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CANADIAN
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The Contribution of Radiology to the Cancer Problem*

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THE contribution which radiology is capable of making towards the reduction of the present mortality from cancer is important both in diagnosis and treatment. It has been repeatedly emphasized that success in the treatment of cancer is being attained chiefly, if not altogether, in cases which are treated during a reasonably early stage of the disease. This statement is equally true for both surgical and radiological methods. Because of this fact there is no doubt that the most urgent single requirement in the campaign against cancer is early and accurate diagnosis followed by prompt and effective treatment, and if these two requirements could be fulfilled the death rate from cancer would be greatly reduced with methods of treatment already available.

Radiology as an Aid in Early Diagnosis

Gastric Carcinoma

An excellent example of the value of radiology in early diagnosis is found in gastric carcinoma. It has recently been pointed out by McCarty of the Mayo Clinic that "Up to 1900 no one had ever seen or at least described an *early* cancer of the stomach." Any progress which has been made in dealing with this disease since that time has come about because of its recognition at a stage sufficiently early to permit of successful gastrectomy and certainly the only progress which is at present in sight lies along the line of accurate diagnosis making possible this type of radical surgery in a larger number of cases. Radiological methods of diagnosis offer the only practical means of securing this

**Presented before the Section of Preventive Medicine and Hygiene, Academy of Medicine, Toronto, February 24, 1938.*

information. Moynihan, speaking on this subject, says: "When carcinoma is present, restriction of diet, change of scene and the administration of drugs will bring a measure of relief for a short time. It is not relief that is wanted. It is knowledge. The main inquiry centres upon the radiologist. He alone and not always even he is able to make a diagnosis in the early stages." In order to make the fullest use of which this method is capable, it would be necessary to have patients referred for examination on much less definite criteria than at present usually prevail even if many such examinations proved to be negative; over a large series of cases they would succeed in recognizing a sufficient number of cancers of the stomach in an early stage to justify the whole procedure. An excellent rule would be for the clinician to suspect cancer somewhere in the gastro-intestinal tract in any male patient in the cancer age who begins to complain of *progressive loss of energy* with or without digestive disturbances even before there is loss of weight or any of the other cardinal symptoms of gastric cancer.

The most advanced work in radiological investigation of the stomach consists in very detailed studies of the gastric mucosa in an attempt to recognize pre-cancerous changes and considerable progress has been made along this line. This should make it possible in the future to detect types of gastric mucous membranes more liable to develop cancer than others in addition to recognizing the disease itself at an earlier period due to increasing perfection of technique and skill in the interpretation of slight departures from the normal.

Primary Carcinoma of the Lung

Whether this disease is actually increasing or not, it is a fact that it is being recognized much more frequently than formerly and that in this recognition X-ray examination is still the most useful single agent at our disposal. At present, as in gastric carcinoma, the only cured cases have been those recognized early enough to permit of successful pneumonectomy. With increasing skill in diagnosis it should be possible to recognize this disease at an earlier stage in a larger percentage of cases than is now being done, and in a patient of either sex in middle life the onset of persistent cough or slight recurring haemoptysis should be regarded by the physician as a *demand* upon him for a satisfactory explanation. In this age-group this is much more likely to prove to be primary carcinoma than tuberculosis.

Other Sites

Space does not permit of following the discussion over the entire field but at least three others are of sufficient frequency to deserve mention.

I. *The Genito-urinary Tract.* It should be an axiom of diagnosis that painless bleeding from the urinary tract requires investigation until the cause has been found. And this will prove to be a malignant lesion in some part of the tract in a majority of cases. The final outcome will frequently be decided by recognition of this fact at the onset of the bleeding rather than at the end of several months of ineffective treatment. The advances of the past few years

in radiological methods have revolutionized the accuracy of diagnosis in this field of investigation and these are now essential to it.

II. *The Colon.* Any decided alteration in bowel habit or function in middle life is a danger sign of major importance and if accompanied by slight recurring haemorrhage is again a demand upon the physician for some explanation other than "haemorrhoids." In this investigation the various applications of X-ray methods by means of barium enemata, air inflations, etc., should be routine procedures and have been the means of making successful surgery possible to a greater extent than any other single diagnostic method.

III. *The Maxillary Antrum.* Progressive swelling occurring in a "chronic antrum" may and frequently does mean that the underlying disease is cancer and neither short-wave therapy nor poulticing will be a satisfactory form of treatment. But swelling which is externally visible usually means a late stage of cancer. Here again X-ray investigation at an earlier period would probably have given correct information.

Arthritis, Sciatica, Lumbago

It should be more widely recognized than is apparently the case that progressive pain in the lumbar or sacro-iliac region, especially if referred to the hip, leg or knee, may not be due to "arthritis," "neuritis" or "lumbago" but may be a manifestation of secondary carcinoma whether a known primary has been demonstrated or not. If such pain develops months or even years after a radical amputation of the breast it is far more probably due to such secondaries than to any of the above list of diseases and no long course of treatment under any of these circumstances is justifiable unless accompanied by X-ray examinations repeated at sufficient intervals to recognize secondary carcinoma if present.

Finally, any progressive swelling involving a long bone or in the neighbourhood of a joint should be regarded as a possible primary tumour of bone and demands investigation. In this instance, also, X-ray studies are indispensable and frequently provide the necessary information upon which to base a differential diagnosis.

RADIOLOGY IN THE TREATMENT OF CANCER

In England in the year 1936 of all cases of cancer of which the treatment was reported, 50 per cent. were treated by radiological methods alone, 30 per cent. by surgery alone and the balance by combinations of the two so that in a single paper it would not be possible to cover this enormous field. It may be of value simply to call attention to a few types of cancer in the treatment of which important gains have been achieved. Since most of these results are not otherwise possible it would be interesting to speculate upon the position which would exist if we did not have radiology in its present advanced form. In certain locations a distinct reduction in mortality is accompanied by improvements in cosmetic results and by conservation of tissue, each in itself an important consideration; in other locations the actual saving of life is the sole merit claimed.

Three of the commonest forms of cancer, namely cancer of the skin, of the lip, and cervix uteri constitute an immediate challenge to the medical profession because it seems very obvious that if our present knowledge regarding these lesions were effectively put into practice deaths therefrom could be reduced almost to zero and would consist almost entirely of those few ignorant or misguided individuals who failed to consult a doctor until the disease was in the hopeless stage or who, having received proper medical advice, refused to act upon it.

In cancer of the skin and lip a very useful contribution towards cancer prophylaxis may be carried out through the eradication of certain easily recognizable pre-malignant changes either on the skin or mucous membrane. Such lesions are very easily removed by comparatively simple radiological treatments which cause no pain and are followed by excellent cosmetic results. If all such cases were suitably treated prior to the occurrence of the malignant change or if this is too much to expect, if when the lesion has become actually malignant, all cases were treated during the *early* stage the number of deaths could be reduced to very small proportions.

Statements similar to this are constantly being made by those engaged in cancer therapy, combined with the further statement that if the public were convinced that cancer is not necessarily hopeless more patients would report earlier for treatment. What truth is there for the first statement, and what grounds for encouragement in the second?

RESULTS OF TREATMENT

The remarks which follow are an attempt to answer these questions by an analysis of the results of treatment in several groups of cases arranged according to the stage of disease at which treatment was undertaken.

ORAL CANCER

I. *The Lip*

The results of treatment of 299 cases are shown in figure I. All primary lesions were treated radiologically and were successfully controlled in 93 per cent. of the cases. So far as the primary lesion in lip cancer is concerned therefore, this method may be considered highly effective and has the additional advantage of comparative absence of scarring and the production of a satisfactory cosmetic result.

The complication to be feared here, as in the other forms of oral cancer, is the spread of the disease to the regional lymph nodes. To deal with such secondary involvement radiological methods alone are inadequate, skilful and radical surgery is required and in the later stages this complication frequently presents a successful challenge even to the most radical combinations of surgery and radiology. In the 299 cases (fig. I) such glandular involvement occurred in approximately 2 per cent. of the stage I cases; 13 per cent. of stage II; 28.5 per cent. of stage III; and 100 per cent. of stage IV.

Our general subject is the contribution made by radiology to the treatment

of cancer and this will be clear if it is remembered that all of the above glandular complications were treated surgically. But if we are also interested in the broader question of the degree to which cancer is being controlled by modern methods of treatment including both surgery and radiology, it is evident from fig. I that satisfactory results are being secured *when treatment is undertaken early* but that the possibility of cure falls off very rapidly as the disease advances and few if any lasting cures are to be expected in the very late stages by any method of treatment.

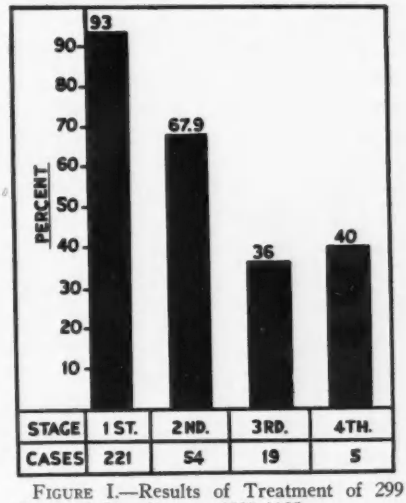

FIGURE I.—Results of Treatment of 299 Cases of Lip Cancer, 1929-1935.

II. *Cancer of the Tongue*

The outstanding contribution of radiology in cancer of the tongue is the conservation of tissue achieved in the treatment of the primary lesion. Control of the primary may be expected in roughly 60 per cent. of all cases with much less loss of tissue, scarring and interference with function than by any other available method. In certain locations this is the only method which offers the patient any prospect of control of his disease and it seems clear from the evidence now available from many sources that in the management of the primary lesion this is the method of choice.

But whether the patient is actually cured of his cancer does not depend upon the control of the primary lesion alone, but whether or not the regional lymph glands become involved and this unfortunately occurs in cancer of the tongue in a higher percentage of cases than in any other form of intra-oral cancer. This complication at present can be controlled only by effective co-operation between the surgeon and the radiologist and there is no room for doubt that such co-operation has produced better results than either alone. There is every indication that present results can be materially improved but even at present there is distinct cause for encouragement in the treatment of this form of cancer always providing the disease is recognized as cancer and correct treatment instituted during the early stage of the disease.

Figures II and III fail to bring out benefits which may be secured which fall short of actual control of the disease. Such palliative benefits are frequently quite considerable but are difficult to present in graphic form. One apparently hopeless case among the eleven stage IV cases has been carried with comfort for over four years by radiological treatment only, and is carrying on his regular occupation although palpable glands are still present and probably contain latent cancer cells.

Other Forms of Intra-Oral Cancer

Similar statements could be made regarding nearly all of the other forms of cancer occurring within the oral cavity but the facts to which attention is especially directed at present and which are shown in fig. II are as follows: of a total of 154 cases in this group only 28 were admitted for treatment during the *early* stage but of these 96.4 per cent. were apparently cured—surely an encouraging fact. The next stage represented the largest group, viz., 64 cases out of 154, or 41.5 per cent., and at this stage the percentage in whom the disease

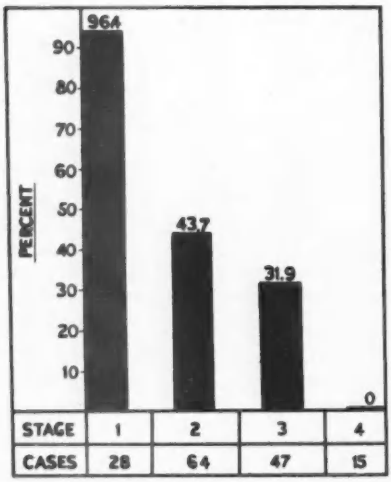

FIGURE II.—Results of Treatment of 154 Cases of Oral Cancer (General), 1929-1935.

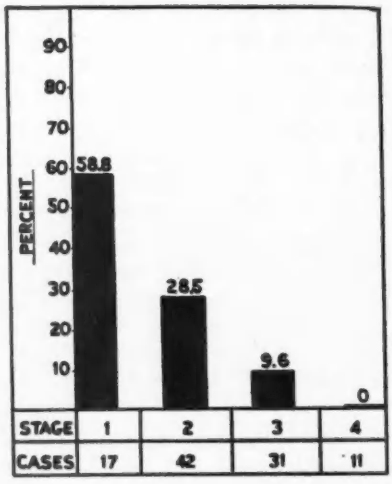

FIGURE III.—Results of Treatment of 101 Cases of Cancer of the Tongue, 1929-1935.

was controlled has fallen to 43.7 per cent. In the third stage this percentage has again fallen to 31.9 per cent. and in the later stage still no cases were actually controlled although many were benefited temporarily. However, to use Moynihan's expression, it is not temporary benefit that is wanted, it is cure of the disease and since this may be expected in something over 90 per cent. of the early cases and only 40 per cent. a few weeks later, to permit or countenance delay or to waste time in trying out methods of treatment which have less to offer is to assume a very serious responsibility. There is no field in medical practice in which a mis-step or wrong procedure is so sure to be followed by disastrous consequences.

CARCINOMA CERVIX UTERI

In an earlier paragraph it was stated that cancer of the cervix was one of the forms of cancer in which the death rate could be greatly reduced if methods of treatment at present available were fully utilized. This statement is based upon a study of the results of treatment in 330 cases which in the early group

show a high percentage of cases alive and free of disease three and five years. The weakness of the statement lies in the fact that this high figure represents a small percentage of the total. But even making all these allowances it is clear that the results in *early* cases are distinctly encouraging. That this is largely offset at present by the discouraging fact that 65 per cent. of all cases are in a late stage of the disease when first seen is not so much ground for pessimism as it is an urgent indication for the need of education both of the laity and of the profession. The fact that abnormal uterine bleeding at any age but especially at or after the menopause is not "nature's outlet" but is a danger sign frequently of tragic significance should be known to every woman. And every doctor should feel it his duty to thoroughly investigate every such case regarding which he is consulted until the cause of such bleeding has been accurately determined. In this way it would be possible to improve the situation so that more cases will be sent for treatment during the early stage when the outlook is favourable.

The second requirement is of equal importance and this is correct and adequate treatment once the diagnosis has been established. It has become increasingly evident during the past several years that radium alone has very definite limitations and that any improvement upon past results requires that treatment be carried out by a carefully planned combination of radium and external irradiation by high voltage X-ray therapy or a suitable radium "bomb". In the beginning it was thought that this applied only to the later cases but it now seems clear that it should be used in all, even the earliest. The method is time-consuming and difficult but present indications point to an improvement in five-year survivals of approximately 30 per cent. as a result of such combined therapy.

In the work reported in fig. IV, the cases have been divided into two main groups which may be called the "early" or operable and the "late" or inoperable. If the early cases are again broken up into the usual stages I and II, the effect of even slight delay in diagnosis is strikingly apparent since between these two groups there is a drop of 40 per cent. in the curability. It is noted also as might have been expected that the difference between the three- and five-year survivals is greater as the stage of the disease advances. In the first stage there is a falling off of only 2.8 per cent. between the third and the fifth year whereas in the next group it is 11 per cent. Taking the two early groups together, the falling off is approximately 10 per cent. It would appear also that three-year averages may be used as a fairly accurate guide in assessing the value of various methods used in treatment.

CANCER OF THE BREAST

The discussion of this problem has suffered more than most other forms of cancer from confusion due to the habit of lumping all types and stages of the disease together. As a result, not infrequently, attempts are made to compare results which are simply not comparable and little progress can be expected until methods of indicating the stage of the disease are generally adopted as has been the accepted rule in cancer of the cervix uteri for many years. When this

is done it will be apparent at once that *the appropriate treatment must vary with different stages of the disease.*

Stage I

In stage I cases, radical surgery as at present practised offers such a high percentage of cure that it is the method of choice and radiology has little to offer in the average case. When the disease occurs in young women the question of artificial sterilization by X-ray applications to the ovaries deserves consideration. There is now a considerable mass of information on this subject, much of which is favourable. But the chief hope lies in further education of the public in order to ensure detection of the disease at this early stage in a larger percentage than at present, as present, as stage I cases now represent less than 15 per cent. of all mammary cancers, and therefore do not represent the main problem.

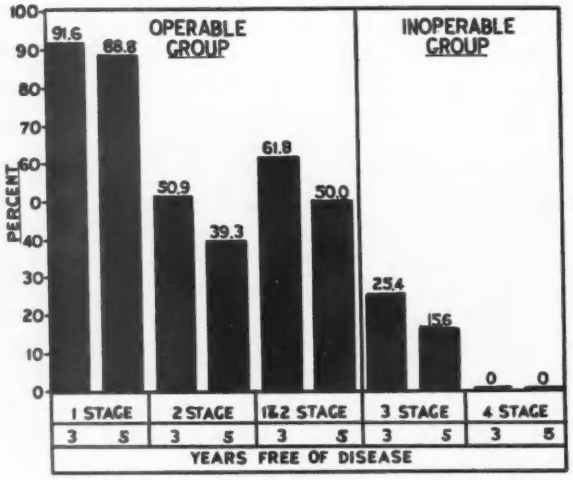

FIGURE IV.—Results of Treatment of 330 Cases of Cancer of the Cervix, 1929-1937.

Stage II

Stage II cancer of the breast introduces the complication of involvement of axillary glands and in this group the percentage curable by surgery alone has fallen to less than 25 per cent. In the past reliance has been placed upon the post-operative use of X-ray therapy to prevent recurrence and improve these results. Some success has attended this form of radio-therapy and by its use the percentage of recurrences has been reduced from 25 per cent. in the hands of some to as much as 50 per cent. in others. But this is only part of the benefit of which radiology is capable and it is now quite clear that a further very substantial improvement could be secured by the systematic and skilful use of radiotherapy both *pre-operatively and post-operatively.* It is the opinion of most radiologists of experience that this pre-operative use of radiotherapy has far greater possibilities for good than the post-operative therapy. Briefly, the facts appear to be as follows: a certain percentage of mammary cancers are highly radiosensitive but these are also extremely malignant and tend to metastasize early and widely. In these cases the greatest harm is done by any kind of manipulation and as a class they account for many of the bad results following

surgery. To *follow* an operation in such a case by post-operative radiotherapy may prevent or postpone local recurrence in the field of operation but can have no influence upon the development of remote metastases. These cases on the other hand are greatly benefited by a thorough course of pre-operative radiotherapy and in a certain number of them this form of treatment alone will control the disease.

The second general group of cases are those which are highly resistant to radiation therapy and do well following operation.

If the pre-operative use of radiotherapy did nothing more than separate these two main groups and if surgeons would act accordingly a great gain would result immediately.

Stage III

Cases of breast cancer in stage III are on the border line of operability and would be better if treated radiologically and only those cases operated upon which show sufficient improvement. It is an open question whether even these would not live longer in comfort if not operated upon even though viable cancer cells may be present in the centre of a mass of fibrosis following treatment. Only time can provide the correct answer to this question.

Stage IV

Stage IV cases are so far advanced as to be incurable by any method of treatment but much may be accomplished by way of palliation, the growth retarded and open ulceration frequently prevented.

RECURRENCE AND REMOTE METASTASES

The use of radiotherapy in the treatment of recurrences is well known and probably most recurrences are best treated by this method. The relief of pain in bony metastases following X-ray therapy is one of the greatest contributions in the entire field. Complete relief is obtained in approximately 80 per cent. with healing by recalcification in a smaller number. While few permanent cures are obtained, the palliative benefits experienced are so general and so satisfying as to form an indication for this use of radiotherapy in all such cases.

SUMMARY

The main purpose of the present paper has been to present evidence that in certain types of cancer a high percentage of cures may be expected by methods already in daily use and that in several groups the results of treatment are at present very satisfactory if treatment is undertaken at a reasonably early stage. Considerable progress has been made in methods during the past few years and this progress is still continuing. But while such improvements have extended the usefulness of the method and have made it possible to treat successfully a larger number of late cases than formerly, it still remains true that most advanced cases are incurable and any real future progress depends upon early diagnosis more than upon any other single development.

Next in importance to early diagnosis must be placed proper medical advice as to the procedure to be followed in any given case. And such advice cannot be given by any one, either surgeon, radiologist, or general practitioner, who sees only a few cancer cases in a year. It has been repeatedly pointed out that mistakes in the early period of the management of cancer are more commonly followed by tragic consequences than in almost any other branch of medicine. The future depends as much upon an educated and unprejudiced medical opinion as to what should be done as upon a correct diagnosis, and in this situation unwise and inadequate surgery or ineffective and unskilful radiotherapy are equally to be condemned.

Tuberculosis Mortality and Morbidity in the Counties of Lincoln and Welland, Ontario

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THE Counties of Lincoln and Welland are situated in the Niagara Peninsula, being bounded on three sides by Lake Erie, the Niagara River, and Lake Ontario. The total estimated population of the area in 1936 was 147,234. Fifty per cent. of the population live in three towns of 5,000 and over and three cities of 10,000 and over. It must be noted that the urban centres are fairly highly industrialized, especially in Welland County. The areas surrounding the towns and cities, which for the purpose of the paper will be considered rural, actually have a large percentage of the population employed in industry. The nationality, especially in industrial areas, is largely foreign; so much so that since the opening of our institution in 1930 forty per cent. of male patients admitted have been of foreign birth, chiefly Central European in origin. The female sanatorium population has averaged 14 per cent. of foreign birth. Public health activities in the area are under the direction of no fewer than 27 medical officers of health.

The Niagara Peninsula Sanatorium was opened in 1930 as a building of 84 beds, fairly centrally located to the two counties. The sanatorium, as well as caring for the tuberculous sick, has complete supervision of the clinics and the follow-up work in the two counties. To this end, the institution has employed two full-time nurses whose salaries are paid by funds raised through the sale of Christmas seals. One of these nurses does all the tuberculosis visiting-work in Lincoln County including St. Catharines, an area having a population of 58,276. The second nurse works wholly in Welland County. The population here is 88,958, which is numerically too great for one nurse to supervise. Nurses who do generalized public health nursing in Niagara Falls, Stamford, and Fort Erie, give part-time assistance in the tuberculosis program. The latter municipalities have a total population of approximately 30,000. Physicians for clinic work are supplied by the sanatorium and the cost of all x-ray work is borne by the sanatorium, although in some instances general-hospital equipment is used. Chest clinics operate weekly in St. Catharines and Niagara Falls, bi-monthly in Welland, monthly in Port Colborne, and also in Lincoln County during the summer months. Each municipality which is served

**Presented before the Section of Vital Statistics and Epidemiology at the twenty-sixth annual meeting of the Canadian Public Health Association, Ottawa, June, 1937.*

by a clinic contributes towards its maintenance by making a yearly grant to the sanatorium. A clinic operates daily at the sanatorium.

A study of mortality and morbidity of tuberculosis is helpful for several reasons. Tuberculosis deaths may be considered failures from the standpoint of our public health program, although it is readily understood that some cases who develop tuberculosis, no matter what type of treatment they receive, will not recover from the disease.

A mortality study is really a post-mortem examination of the entire number of deaths occurring from the disease. During the past ten years there has been a considerable improvement in the certifying of causes of death by physicians and a redistribution of deaths according to place of residence has been made through the co-operation of the Dominion Bureau of Statistics, Ottawa, and published by the Registrar General of Ontario. Although there has been this improvement in certifying of causes of death, notably the use of the new Canadian death certificate, there is still much to be accomplished in obtaining more accurate certification. Deaths which occur in institutions are probably registered fairly accurately but even in institutions errors may be made when post-mortem findings are not available. Three cases, of which there are several quite similar, are cited as examples. Last year there was a patient, fifty-six years of age, who had been treated for tuberculosis some three years previously. He was readmitted in general ill-health and although his sputum became positive shortly after admission, his chief complaint was abdominal. He had developed a large abscess in the right lower quadrant. The diagnosis was not definitely established until post-mortem examination, when it was found that he had carcinoma of the caecum; this was the primary cause of death. Another case, an unmarried girl, was admitted with active minimal tuberculosis and a complication of pregnancy. She left the institution in a few weeks against advice, and selected a physician other than the one who had referred her to the sanatorium and gave him no information regarding her tuberculous condition. Following the birth of her baby, she developed tuberculous pneumonia. The infant soon after developed meningitis, but the cause of death in this case was not recorded as tuberculous meningitis. There is no doubt, however, as to the real cause of death. A third case is that of a boy whose sister had died of tuberculosis, and who showed moderate involvement of tracheo-bronchial glands. This boy eventually died, and the cause of his death was septicaemia. However, when we obtained a list of deaths from tuberculosis for 1935, he was included in the list as having died of that disease. I merely mention these errors in cause of death as listed on the death certificates to point out errors which are likely to occur in this type of statistical study. One might consider, however, that mistakes probably balance, giving a mean average which is, for practical purposes, accurate.

STUDY OF MORBIDITY

Through the public health nursing service and the sanatorium, specific information is made available regarding all known cases of tuberculosis in the two counties. All the essential data are available, including the type of tubercu-

losis, the clinical condition, positive or negative sputum, etc., whether at home or in the sanatorium. In table I the tuberculosis case-count for September, 1936, is presented.

From table I it is noted that there were 592 cases of pulmonary tuberculosis and 59 of other forms of tuberculosis. Of these, 71 were in the Niagara Peninsula Sanatorium and 9 in other sanatoria. There were 47 patients at home who had positive sputa.

From the data of table I, and using an average of 45 deaths per year (1933, 1934, and 1935), it appears that there were 14.4 known living cases of tuberculosis for each death. Classifying these into stages of activity, as active, quiescent, apparently arrested, and arrested, there were 4.6 cases of active tuberculosis for each death. There were in 1936 2.4 cases with positive sputum for each death. Of the 24 patients with a positive sputum not in sanatorium, many were advanced cases who, when suffering from a cold, had occasional positive sputum. Others had sputum which was negative on direct smear and positive on culture.

As it was not possible to classify our morbidity into age-groups, I obtained from Dr. Louis I. Dublin an estimated incidence of tuberculosis in Lincoln and Welland counties, based on Bigelow and Lombard's findings in Massachusetts. In this survey of chronic diseases, Bigelow and Lombard point out that tuberculosis was under-reported and that their study indicates that the figures should be increased by 50 per cent. This correction has been made, and in table II Dr. Dublin's estimate is presented.

It is interesting that the estimate of Dr. Dublin places the number of cases of pulmonary tuberculosis in the two counties at 597. We have a record of 592 cases.

The factors which have tended to decrease our mortality rate have at the same time increased our morbidity rate; for instance, examination of contacts brings to light cases of tuberculosis without symptoms and these increase our morbidity total. Most of these early cases proceed to complete recovery. Our program has stressed the early discovery of cases of tuberculosis. It is interesting to record the number of new cases of tuberculosis (all forms) found during the period 1930-1936. In 1930 there were 139 new cases; in 1931, 150; in 1932, 148; in 1933, 138; in 1934, 157; in 1935, 134; and in 1936, 126. In the last two years there has been a significant fall in the number of new cases. A public health nurse was first employed in 1932 and during the past two years all resident contacts of those who had died from tuberculosis during the previous ten years were visited, and as many as possible were examined in the clinics. With the completion of this work, the number of new cases naturally fell.

The number of new patients examined during the period 1930-1936 has averaged 1,064, varying from 870 in 1931 to 1,206 in 1934. In 1936, 1,105 new patients were examined.

The importance of re-examination is fully recognized and the number of such examinations has steadily increased. The total number of examinations, including the examination of new patients, has increased from 1,336 in 1931 to 3,486 in 1936. Particular attention has been paid, in conducting re-examina-

TABLE I

TUBERCULOSIS CASE COUNT, SEPTEMBER, 1936

	Pulmonary Tuberculosis			Other Forms	Total	Classification					Pts. in San.		Pts. with Pos. Sputum	
	Min.	MA.	FA.			Act.	Act. Undet.	Quies.	App. Arr.	Arr.	N.P. San.	Other San.	in San.	at Home
St. Catharines	67	35	24	10	136	31	1	56	15	33	7	1	5	10
Lincoln County	45	17	10	19	91	30	12	23	6	20	6	5	5	6
Niagara Falls	57	23	19	6	105	31	12	44	10	8	9	1	9	4
Welland City	30	6	18	2	56	18	4	22	7	5	8	.	3	4
Welland County	123	56	62	22	263	97	26	90	29	21	41	2	38	23
Total	322	137	133	59	651	207	55	235	67	87	71	9	60	47

TABLE II

ESTIMATED INCIDENCE OF TUBERCULOSIS, LINCOLN AND WELLAND COUNTIES, ONTARIO

	Massachusetts Survey, 1929						Lincoln and Welland Counties, Ont.		
		No. of Cases		Cases per 1,000 Population				Estimated Number of Tuberculosis	
	Population covered	Pulmonary Tuberculosis	Non-Pulmonary Tuberculosis	Pulmonary Tuberculosis + 1.5	Non-Pulmonary Tuberculosis	Total Tuberculosis	Population 1931	Total	Pulmonary Only
All ages	46,477	136	43	...	...	...	136,930	724	597
Under 20	16,907	30	19	2.7	1.1	3.8	50,985	194	138
20-39	13,238	43	6	4.8	.5	5.3	42,082	223	202
40-49	6,022	30	8	7.5	1.3	8.8	17,344	153	130
50-59	4,839	13	4	4.1	.8	4.9	12,558	62	51
60-69	3,240	12	3	5.6	.9	6.5	8,285	54	46
70-79	1,690	4	2	3.6	1.2	4.8	4,452	21	16
80+	505	4	1	11.9	2.0	13.9	1,190	17	14
Unknown	36	..	..	...	...	...	34	..	..

tions, to the age-group of 15 to 25 years. Contacts in this age-group are urged to return at yearly intervals for physical and x-ray examination. The following observations are of interest as relating to contacts in this age-group who were followed for a period of one to six years. The group included 143 persons. In this group 7 developed tuberculosis within the first year after contact was broken; 5 between the first and second year; 3 between the second and third year; 3 between the third and fourth year; 1 between the fourth and fifth year; and 2 between the fifth and sixth year.

It is interesting also to record that there was a decrease in the number of children examined in 1936, the number in 1934 being 910 and in 1936, 811. This reduction reflects our policy that, except in early years, the child under fourteen does not need the frequent examinations that were formerly thought necessary. We believe, however, that supervision in the home is essential. In rural and in smaller urban centres a great deal of welfare work must be undertaken in order that the home may be reorganized and that the contacts may receive proper care. In this effort the public health nurse plays the most important part. It is time-consuming but in our opinion is most important. The home is the place where tuberculosis has its beginning and its spread. It is the place to which the discharged patient must return after treatment; and it is only by education and well-directed assistance that we can ever hope to keep under control infection that is already established. The greatly increased number of nursing visits to tuberculosis cases and contacts is evidenced by the fact that in 1932, when the work was commenced with one nurse, 421 visits were made, whereas in 1936, with two public health nurses giving their full time, 4,890 visits were made. In addition to these visits to the homes, the public health nurse must report or discuss matters relating to their home visits with doctors, school nurses, and welfare workers. An additional number of 2,531 such visits was made during 1936 by the two nurses of the sanatorium.

Results of Immunization of Nurses Against Scarlet Fever*

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IN any hospital the problem of epidemic disease amongst the attending staff is of considerable importance both as regards depletion of the staff itself and the quarantine of whole wards or wings of the institution. Immunization against as many as possible of the infectious diseases is a necessity. This principle has for many years been recognized by training schools and large institutions which have required compulsory immunization against smallpox and typhoid fever, and, of late years, it has almost become universal to require toxoid immunization against diphtheria in those who are Schick-positive. Immunization against scarlet fever by injections of diluted toxin has not been nearly so widely used as these other procedures. The reasons for this are varied but appear mainly to be due to lack of faith in the value of the procedure and to a fear of reactions. As our experience at the Saint John General Hospital suggests that this faithlessness and fearfulness are ill-founded, it seems worth while to record our findings over the past thirteen years.

Immunization against scarlet fever was initiated at the Saint John General Hospital in November, 1924, and the practice has been continued since. The procedure at present is to do Dick tests on all probationer nurses within a few weeks of their arrival at the training school. All Dick-positive persons are given weekly injections of Dick toxin, as supplied by the Connaught Laboratories; five such injections are given, having a total of 18,630 skin-test doses. In 1926-27 and 1933 no Dick tests were done, but all who had not previously had scarlet fever were inoculated. Since 1934 all have been retested after inoculation and if still Dick-positive have been reinoculated. It may be emphatically stated at this point that no untoward results have occurred and practically no time has been lost; indeed, the training school authorities state that less time has been lost following these inoculations than after receiving typhoid vaccine or diphtheria toxoid injections.

In order to arrive at some comparative basis we have recorded the cases amongst nurses in training during the years 1920-1924 inclusive. During that time there were 224 nurses in training and there were 11 cases of scarlet fever

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(5 per cent.). From 1925-1937 there were 1,132 nurses in training and there were 5 cases of scarlet fever (0.4 per cent.). Of these, one case in 1925 contracted the disease considerably less than a month after she had received the third dose. Two others were probationers who had not been inoculated. The fourth was a nurse, who, because she was apparently Dick-negative in 1927, was not immunized; she contracted scarlet fever in 1929. The fifth was one who had been Dick-positive, inoculated in 1932, and had not been retested following her course of inoculations; she contracted scarlet fever in 1933. Taking only those in whom immunization can be considered as complete, we have therefore only one case (0.08 per cent.). It is of some interest to note here that only 7.2 per cent. of the nurses gave a history of having had scarlet fever in childhood, whereas 17.4 per cent. were Dick-negative.

The question as to the degree of contact with scarlet fever is a difficult one to answer. Certainly this varies from year to year with the incidence of the disease in the community. Each nurse spends about eight weeks in the infectious-disease annex and those in contact with scarlet fever patients may be assumed to be at least temporary carriers of streptococci capable of causing scarlet fever in susceptible persons. There has been no increase in scarlet fever in the general children's wards during the period of immunization. We have no figures as to the incidence of streptococcal infection amongst the nurses but it is our opinion that this has definitely decreased. We do know that whereas the average time lost due to illness for the four-year period, 1921-1924, was 15.4 days per nurse, it is now less than 9 days.

It would appear that toxin immunization is of definite value in reducing the incidence of scarlet fever amongst undergraduate nurses and that it is unattended by disability.

Blood Groups in Poliomyelitis

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THIS report is based on the study of the blood groups in a series of 703 cases of poliomyelitis, occurring in Toronto and vicinity during the epidemic in the fall of 1937. Of the 703 cases, 494 were grouped by the staff at the Hospital for Sick Children, 169 at the Riverdale Isolation Hospital, and 40 at the Toronto General Hospital. The ages varied from 9 months to 33 years. Three cases were infants of 9 months, two of whom were paralyzed.

Investigation was carried out with a view to determine if possible whether there was any relationship between the blood groups and resistance to infection with the virus of poliomyelitis. Such relationship was suggested by earlier investigators, but in our opinion the size of the groups invesetigated was frequently too small to justify any conclusions. For example, Jungeblut and Smith (1) report that in one group of 40 patients, none belonging to Group B were found among the moderately or severely paralyzed cases over 5 years of age. However, it should be pointed out that only 7 of these 40 cases were in this age-group, a number so small as to be of little or no significance. In a total of 125 paralytic cases occurring over 5 years of age, these same authors report 5.6 per cent. belonging to Group B as compared with 14 per cent. Group B in the control series.

One of these authors, in a subsequent publication (2), appeared to attach even more significance to these figures than in the original article.

Madsen, Engle and Jensen (3), on the other hand, in reporting on a much larger series of poliomyelitis cases in Denmark, concluded that the susceptibility to infection with the virus bore no relation to the blood groups. Our data support this view.

By combining the efforts of the three Toronto hospitals previously mentioned, we were able to determine the blood groups in a series of 703 poliomyelitis patients. For a control series, we selected 1,000 consecutive cases, grouped at the Hospital for Sick Children for transfusion during the months of July, August and September of the same year. These included children and adults of all ages and of both sexes.

The results of this investigation are shown in table I. From this table it will be seen that the distribution of the blood groups in the total series of poliomyelitis cases is strikingly similar to that shown in the control series. For example, among the poliomelitis cases, 11.5 per cent. were of Group B, and in the control series 11.6 per cent. were in the same group. While it is true that minor deviations are seen in some of the subdivisions, it is our opinion that these variations

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TABLE I

DISTRIBUTION OF BLOOD GROUPS IN 703 CASES OF POLIOMYELITIS, INCLUDING 11 FATAL CASES, AS COMPARED WITH 1,000 CONTROL CASES

	Non-paralysed Cases				Paralysed Cases					Total of all cases of Polio.	Controls
Ages in years	0-5	6-15	16+	*Total*	0-5	6-15	16+	Fatal cases	*Total inc. fatal cases*		
No. of cases	97	143	36	**276**	171	205	51	(11)	**427**	703	**1,000**
Group O%	44.3	41.3	58.3	**44.6**	48.0	50.7	60.8	63.6	**50.8**	48.4	**47.7%**
Group A%	30.9	43.3	36.1	**38.0**	40.4	37.1	29.4	27.3	**37.5**	37.7	**40.8%**
Group B%	19.6	12.6	5.6	**14.1**	8.8	10.7	9.8	9.1	**9.8**	11.5	**11.6%**
Group AB%	5.2	2.8	0	**3.3**	2.9	1.5	0	0	**1.9**	2.4	**2.9%**

can be explained on the basis of the small size of these particular groups. The results of this study, therefore, would indicate that there is no relationship between blood groups and the individual resistance to infection with the virus of poliomyelitis.

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Communicable Diseases, Past, Present and Future*

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IT is a rather difficult matter to select a subject that will prove instructive and interesting, but I have endeavoured, as the title indicates, to select one which should give us a full and free discussion with resulting benefit to all who are health officers and to the communities in which we live.

My mind goes back many, many years to the distant past when scientific medicine had not reached the high place it occupies to-day. Bacteriology and pathology were more or less unknown to us, but with the knowledge of infection given to us by the great Pasteur, and on which Lister built what we now know as Listerism and antisepsis, and with the contributions of later investigators, we have now reached the stage where we should be able to prevent and control communicable diseases.

Half a century ago and previously, taking smallpox as an example of an infectious and contagious disease now designated by the more acceptable term of a communicable disease, a house in which it occurred was placarded and a constable watched it day and night to prevent anyone leaving. Every member of the household and all contacts were vaccinated. Food was supplied by the health authorities at the expense of the municipality until such time as all scabs had disappeared. The house was fumigated with sulphur, the great purifier of that day, and the rooms thoroughly cleaned, after which the patients were released. In some communities a house, or what was known as an infectious hospital, was set aside and the infectious patients removed for treatment, the remaining members of the family being kept under quarantine until all danger was past.

Diphtheria, scarlet fever, and other infectious cases were cared for in a similar way and perhaps I may be allowed to point out that the type of all these diseases was much more virulent than we find it to-day; confluent and haemorrhagic smallpox were quite common, and the death rate much higher. Diphtheria and scarlet fever were deadly diseases with no specific treatment for either. Compare that with the present method of prevention and treatment and caring for these diseases.

I think that it is safe to state that these diseases have diminished in virulence and the mortality rate is much lower than formerly. It is true that the general use of vaccination has more or less eradicated smallpox. The treat-

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ment of diphtheria by antitoxin has greatly reduced the death rate from that disease and the immunization of preschool and school children with diphtheria toxoid has practically eliminated the disease in those communities where immunization is thoroughly conducted. We now look upon this formerly most fatal disease as being well under control and easily preventable.

Encouraging results are being obtained in the prevention of scarlet fever by the use of scarlet fever toxin, and although not as effective as diphtheria toxoid in the prevention of diphtheria, yet many cases of scarlet fever are being prevented by the use of this immunizing agent.

Through the chlorination of municipal water supplies, the use of typhoid vaccine as a preventive, and the elimination of carriers from handling food supplies, typhoid fever, which formerly caused a high mortality rate, has been effectively controlled. The late world war demonstrated very conclusively what preventive medicine can do. Practically every soldier was inoculated against typhoid, with the result that comparatively few cases occurred and the death rate was low among our men. When we compare this with our experience in the South African War, when more soldiers lost their lives through disease than by bullets, we can easily appreciate the great advance made in preventive medicine through the different ages. Among the 420,000 men in the Canadian Expeditionary Force in the Great War, 421 cases of typhoid were reported, with 14 deaths. All troops received the protective vaccination. In the South African War 57,684 cases of typhoid fever were reported, with 8,022 deaths. These figures indicate the great progress that has been made in the prevention of typhoid fever from the time of the South African War in 1899 to the Great War in 1914. The use of typhoid vaccine was unquestionably the factor of major importance in the remarkably low incidence of typhoid fever in the overseas forces in the Great War.

Perhaps we may consider for a few moments our health situation in Nova Scotia. A few years ago the Government of the day decided to reorganize the health department and place at its head a Minister of Health. This was done under the Rhodes Government and the Honourable Dr. Murphy became the first Minister of Health. During this period Dr. Murphy carefully organized the department and laid the foundations of the present effective organization. When the change of Government occurred, the Honourable Dr. F. R. Davis became Minister of Health and he has continued the good work begun by his predecessor. It is a great satisfaction to know that under both Ministers of Health there has been a steady improvement in the health of the Province and the death rate has fallen. The work of this department has not been influenced by political interests. The health officers throughout the Province feel that in Dr. Campbell they have a chief health officer who inspires them with every confidence.

It might be interesting to know that we believe that Sydney is an exceedingly healthful city. The infant mortality rate in 1936 was only 30, approximately half of that of Nova Scotia. This rate is almost the lowest infant mortality rate in the Dominion of Canada. Further, we have not had a case of

typhoid fever originating in our city for several years. Cases have been treated in hospital but the patients received their infection in outside districts.

The infant mortality rate of the Province of Nova Scotia has gradually lessened. In 1908 the rate was 108 and this has gradually been reduced until in 1936 the death rate was only 66. The Provincial death rate from tuberculosis in 1910 was 230 per 100,000 and in 1936 it was 92, representing a reduction of 60 per cent.

Our views regarding the spread of infection have changed greatly since early days. We now know that infection through direct contact of persons most frequently occurs, and not through rooms, clothing, etc. While no health officer would ignore the danger of infection from clothing, toys, etc., the person ill with the disease or carrying the infection must be watched closely to prevent the spread of disease. To-day if a case is isolated properly, it is safe to allow the bread-winner to go to work, provided that he is not handling food.

There are other serious infectious diseases such as infantile paralysis which spread rapidly and are not yet thoroughly understood, nor is the prevention or treatment satisfactory.

Time will not allow me to do more than mention one other disease which I wish to bring to the notice of the meeting and that is syphilis, which, with its effects on all organs of the body, is perhaps the greatest killing disease known to us. It is true that we have made great advances in treatment and every health department, through free clinics and treatment, is doing its utmost to control this disease, but until each and every case is reported, isolated to a certain degree at least, and punishment meted out to those who knowingly spread it, it will be difficult to stamp out this fearful disease.

Now what about the future? What has that in store for us? We all remember the horse and carriage at six miles an hour, the automobile at twenty to sixty miles an hour, the aeroplane at one hundred and fifty miles an hour, and then the racing car at three hundred and twelve miles an hour. What increased speed! The telegraph and telephone, and especially the radio, carry our conversation clear and distinct across the world. What advances in a few years! Is it too much to expect that the future has in store for us the same great advance in preventive medicine that has already been made in the broad field of science? We can look forward to the future with every hope and confidence.

Control of Communicable Disease: A Federal Responsibility*

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AS one of the health officers of Nova Scotia, I greet my confreres from all parts of Canada, and hope that their respite in Halifax, the home of the immortal Howe and of three Prime Ministers of Canada, will, in addition to a whiff of the Atlantic sea-breeze, give a hint of the hospitality, national thought and outlook of this eastern part of our broad Dominion.

Ever since the discovery of the causative germs of communicable diseases, the profession, day in and day out, has endeavoured to inculcate the doctrine that there is no safety for the family, the community or the state, so long as the person infected, the host of the specific germ, is at large. The silent, subtle reasonings of men of science revolutionized the hitherto-held theory of heredity, cesspools, etc., and ushered in the new era of prevention. It soon became apparent that the person infected was the source of infection, and that garbage cans, sinks and cesspools, although unsightly and shocking to our aestheticism and self-respect, could not transmit communicable disease unless the germ were first introduced into them. Pasteur long ago exploded the theory of spontaneous generation. It was largely on the hypothesis of this theory of heredity that the old doctrine of causation was based and measures of prevention directed. Before 1882, for instance, consumption was considered hereditary. No thought was given to the fact that the consumptive person alone is the sole and only source of infection, as shown by Koch's discovery of the tubercle bacillus, nor that isolation would be a good preventive measure. It took a good many years after Koch's discovery to dispel the old theory of heredity. Gradually, sporadic measures of control by institutional treatment were made. To-day there is at least one sanatorium in every Province and the whole sanatorium movement receives a large measure of Provincial-Government support.

I believe that the control of communicable diseases never should have been made the burden of our local governments. If the Fathers of Confederation, or the law officers of the Crown, who drew up the British North America Act, could only have had a vision of the future, in the light of present-day knowledge, they assuredly would have realized that prevention of the spread of communicable disease was no local responsibility but a great national obligation. Is there any other problem so transcendent, so vital, so far-reaching, or easily solved as "prevention of the spread of communicable diseases"? Granted the necessary

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equipment for isolation housing, the necessary money for maintenance, Scotland Yard organization in detection and isolation, enabling laws for detention of open cases, good care and treatment, I am convinced that not only consumption but all communicable diseases can be wiped from the face of the earth. There should be no compromise with home treatment and education. This compromise is quickly taken advantage of as a cheap way of escaping national obligation. There is no adequate safety in home treatment, no matter what precautions are taken. Education, while a help, is not all that is necessary. Surely, then, if the Federal Government will open their eyes, they must realize that, in co-operation with local governments, this is a national responsibility, though not so stipulated in the B.N.A. Act. It is, however, stipulated in the Act that the horse, cow, and pig, the leper, the gun of the highway man, the raving maniac, can all be detained for public safety. It is not so easy to see the writhing organism of syphilis, the lurking organisms of gonorrhoea, smallpox, typhoid fever, tuberculosis, etc., millions of which and of other causes of communicable diseases may be entrenched within their citadels in the human body, more deadly than the gunman, and most of them at large. Whose responsibility is it to apprehend and detain those who, day by day, sow the seeds of destruction? The point which I wish to emphasize is that this is not a local government problem but a national problem and that the B.N.A. Act should be forthwith amended to meet the urgency of radical measures of control.

Within recent months, the Parliament of Great Britain has been asked for a precise and specific statement or amendment to the British North America Act to enable the Parliament of Canada to proceed at once with the centralized, Dominion-wide, much-needed social program of "maternity benefits, unemployment insurance, widows' pensions, old age and invalidity pensions". Not one word, not one thought probably, was given in this submission to the national responsibility for the spread of communicable disease, or to any suggested enabling alterations to the B.N.A. Act to cope with this problem, greater by far than all the social program above enumerated. Let us be united, definite and dogmatic in stressing our belief, and let us harken to the cry of humanity: "Save us from our friends; awaken our sleepy representatives, and beg them to take a look into the situation as it exists."

In conclusion, may I say I sometimes ponder the discoveries of the great men who have done so much for the prevention of the spread of communicable disease. Where can we find examples of devotion equal to theirs? Their patient, intensive pursuit of an ideal, their perplexities, fears, doubts, and hopes and their thrills on the discovery of the specific organism causing the disease under investigation have no counterpart in any line of action.

We sometimes marvel at the indifference of the public—the beneficiaries of these "findings", and the lack of appreciation and even opposition of our governing bodies in implementing the discoveries for the benefit of humanity. Notwithstanding all this, their memories will never die. They blazed the trail—they led the way.

The Demonstration of Types of *B. Typhosus* by Means of Preparations of Type II Vi Phage

I. Principles and Technique

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PHAGES which are specific for the V (Vi or virulent) form of *B. typhosus* have been reported by Craigie (1936), Craigie and Brandon (1936 a,b), Sertic and Boulgakov (1936) and Scholtens (1936). Craigie and Brandon (1936 a) observed a complete parallelism between sensitivity to one such phage (phage Q151) and the development of V agglutinogen. The W form of *B. typhosus,* as well as various Salmonella species available at that time, was found to be resistant to this phage. This study was subsequently extended, a total of 648 cultures of *B. typhosus* being examined without exceptions being noted to the specificity of phage Q151 (Type I phage) for the V form. It was also ascertained that the East Africa strain of *B. paratyphosus C,* found by Kauffmann (1934-5) to be agglutinable by typhoid V serum, showed a modified sensitivity to phage Q151, thus providing further evidence of an intimate correlation between the development of V agglutinogen and sensitivity to this type of phage.

During this investigation, other specific Vi phages[2] were isolated from time to time from lytic V or lysogenic W[3] cultures obtained from stool or urine specimens. A comparison of these strains of Vi phage revealed certain differences which were briefly reported by Craigie and Yen (1937). These differences are summarized in table I and a fuller account of comparative observations on these phages will be published later.

It will be noted that four distinct serological types of specific Vi phage have been encountered. None of these phages have been observed to attack W forms or other Salmonella species. As well as differing in serology, particle size, and thermal death-point, they differ in their lytic activity for different V form strains. In attempting to obtain an explanation of these differences in strain affinity, the phages were examined on a number of strains of *B. typhosus* and it was observed that strains known to be associated epidemiologically reacted similarly in certain particulars. An endeavour was therefore made to group strains of *B. typhosus* by applying selected dilutions of phages I, II, III, and IV

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[2]*In view of the manner in which the different phages belonging to this group have been designated, it seems desirable to abandon the term V phage used in previous communications.*

[3]*W in character as determined by agglutination tests.*

to plate cultures of the strains under examination. However, this particular method was found to demonstrate too great a number of differences in relative sensitivity of strains of *B. typhosus* to the phages. It was abandoned because of the difficulty of assessing the significance of many of these differences and because marked discrepancies were noted in the results obtained with different type II phage preparations. Investigation of these discrepancies revealed that

TABLE I

Vi Phage	Relative Particle Size	Thermal Death-point (30 min.)	Neutralization by Antiphage Serum I	II	III	IV	Lytic activity for V Forms of *B. typhosus*
Type I.....	Large phage	67-70°C.	+	−	−	−	Lyses all V forms
Type II.....	Medium phage	69-72°C.	−	+	−	−	Develops a high selective lytic activity for the type of *B. typhosus* on which it is propagated
Type III.....	Small phage	61-64°C.	−	−	+	−	Lyses majority of V forms
Type IV.....	Medium phage	59-62°C.	−	−	−	+	Lyses majority of V forms with exception of type F (Rawlings-Watson) and D_1

the affinities of this phage were conditioned by the particular strain of *B. typhosus* on which it had been propagated. For example, phage II, when grown on the Rawlings or Watson strains, develops an equally high lytic activity for both these strains but affects strain Ty_2 only when applied in relatively strong concentrations. Grown in turn on strain Ty_2, this phage loses its selective affinity for the Rawlings and Watson strains, developing instead a high affinity for the Ty_2 strain. It was found that by changing the substrate strain of *B. typhosus* in this way, a number of differently reacting preparations of phage II could be obtained and duplicated as desired. While we were primarily interested in this phenomenon from the virus point of view, it was obviously necessary to inquire into the possible significance of the differences in strains of *B. typhosus* thus revealed. Efforts were therefore made to examine an extensive series of strains and to collect as much epidemiological information as possible concerning them.

In presenting our observations on Vi phages and *B. typhosus,* it has seemed preferable to deal first with those which relate directly to the question of the existence of different V form types of *B. typhosus,* particularly since epidemiological information can be employed as a basis on which the significance of differences between strains of this organism can be assessed. Obviously, any satisfactory interpretation of the observed variations in the behaviour of phage II must be based, in turn, on observations relating to the question of the existence of independent and stable types of *B. typhosus.* The purpose of this

paper is to describe a method whereby different types of *B. typhosus* may be identified by means of conditioned preparations of phage II. The method, it is to be noted, represents a simplified procedure which is suited to the routine typing of freshly isolated strains of *B. typhosus*. This paper will be followed by a presentation of the results obtained by this method along with relevant epidemiological information. Other observations on phage II and other Vi phages must necessarily be published elsewhere. It will be realized, however, that it is impossible to exclude from the present paper all reference to certain observations on these phages which can only be described in detail at a later date. Therefore, it may be stated at this point that we have failed to obtain evidence of change in the serological or physical characters of type II phage in the course of the changes in strain affinity which it has undergone on propagating it on different strains of *B. typhosus*. The investigation of the changes in affinity of type II phage and the application of preparations of this phage to the typing of *B. typhosus* have been largely based on the hypothesis that this phage exists as a number of mutants, differing in their affinity for different types of *B. typhosus*. While we do not at present suggest that this hypothesis is correct, it has proved to be a profitable working hypothesis and a brief outline may aid the reader in following a description of the method of typing *B. typhosus* by means of this phage.

Some of the variations of animal viruses are believed to be true mutations, involving a discontinuous change in character instead of temporary, reversible fluctuations induced by environment which are akin to *Dauermodifikationen* (*vide* Findlay, 1936). Mutation is recognized to occur in the case of plant viruses, Jensen (1936, 1937), for example, having isolated over 50 viruses considered to be mutants of tobacco mosaic virus. In the case of phage, changes which appear to be mutations have been described by d'Herelle and Rakieten (1934). The former, studying phage induced mutants of *Salmonella enteritidis*, found that the phages carried by these bacterial mutants differed in their relative virulence for the various mutants as well as for the parent phage-free strain. Burnet and Lush (1936) observed a mutant of a staphylococcus phage and Asheshov, Asheshov, Khan, Lahiri and Chatterji (1933) have observed a dissociation phenomenon occurring with cholera phage. In the case of Vi phages there is no *a priori* reason for considering that mutation cannot occur. Postulating that mutation may occur, it is to be expected that any mutants which might arise would either die out, or at least fail to replace the original phage, unless the environment was altered to one selectively favouring their growth. Since the phages under consideration are specific Vi phages, any differences in environment which might favour the development of a particular Vi phage mutant could be provided only by hitherto unrecognized differences between strains of *B. typhosus*. Assuming that such differences actually exist, it follows that a series of V form strains exhibiting such differences would provide a means of experimentally isolating and propagating the various phage mutants. Assuming constant mutation rates for the phage, any preparation of phage would contain, in addition to the dominant mutant determined by the nature of the typhoid strain,

a low proportion of other mutants which, however, would fail to multiply to any significant extent. Selective propagation of any one of these other mutants could be effected, however, if a strain capable of supporting the growth of the mutant in question were substituted for the original strain of *B. typhosus*. By selectively propagating mutants in this way a series of phage preparations would be available which would show a high relative affinity for the homologous strain of *B. typhosus*. Such preparations, diluted to contain only an effective number of particles of the dominant mutant, could thus be employed to identify strains of *B. typhosus* similar in type to that on which they were grown. This, briefly, is the tentative hypothesis which was evolved to explain early observations on the behaviour of phage II and which has resulted in the development of a method of typing *B. typhosus* which yields results compatible with epidemiological observation. The problem of the validity of the hypothesis is a matter, however, which must be deferred for subsequent discussion.

After a preliminary investigation of the variations in strain affinity of type II phage, during which some confusion was experienced as a result of including types B and D (*vide* table III) among those examined, the following steps were taken in an attempt to apply the phenomenon to the typing of *B. typhosus*. Type II phage was first studied on the Rawlings, Watson, and Ty_2 strains of *B. typhosus* and then on further strains found to be relatively resistant to the Rawlings, Watson, and Ty_2 phages, until it was established that the behaviour of the phage was consistently conditioned by the strain on which the phage had last been propagated. An example of the results obtained with strains Ty_2 and Watson is shown in table II.

A series of recently isolated V form strains from cases and carriers was next tested with standardized high dilutions of Rawlings and Ty_2 phage which clearly distinguished these two strains. A number of strains were found to be attacked by these specific dilutions of the Rawlings or Ty_2 phages, but many were resistant. A strong concentration of phage was added to one of the resistant (non-lysogenic) strains and from a single plaque the phage was propagated to an estimated extent of 10^{31} on this strain. This new preparation was tested with types I, II, III, and IV phage antisera and was found to be neutralized only by type II antiserum. The strains of *B. typhosus* found to be resistant to the Rawlings and Watson phages were then tested with this new phage preparation and a number were found to be similar to the strain used for its preparation. From the remaining resistant strains a fourth non-lysogenic strain was selected, and by means of phage propagated on it, and confirmed to be type II phage, strains similar to this fourth type were identified. This procedure was continued until a residue of strains remained which showed, at most, only transient lysis with type II phage. Attempts to propagate this phage on some of these strains in broth and on solid media resulted only in loss of the phage. These strains, described below as "imperfect" strains, do not completely lack sensitivity to phage II but the period of logarithmic growth of the strain during which they react in any visible way to the phage is so limited that they cannot be typed.

TABLE II

Sequence in which phage was propagated on strains Q285, Ty_2 and Watson	Phage propagated on strain Ty_2			Phage propagated on strain Watson		
	Degree of Propagation	Titre for		Degree of Propagation	Titre for	
		Ty_2	Watson		Ty_2	Watson
Transferred from type A strain (Q285).....	10^{39}	1 in 10^7	1 in 10	10^{29}	1 in 10	1 in 10^7
Transferred from titrated sample of Ty_2 phage				10^{34}	1 in 10^2	1 in 10^8
Transferred from titrated sample of Watson phage.....	10^{38}	1 in 10^7	1 in 10			

After a number of types of *B. typhosus* had been differentiated in the way described, the findings were checked (a) by testing all strains with all phage preparations used for typing, and (b) by propagating phage II on several groups of apparently similar V form types and comparing the resultant phage preparations by differential titration on type strains. The latter procedure showed that similar strains yielded similar phage preparations. In several instances, this result was obtained with a carrier strain and strains from individuals known to have been infected by him. The question of homogeneity of the strains was investigated by multiple single colony isolations from a number of strains of different types. In no instance has the presence of two or more typical V form types been noted in a culture, although mixed cultures consisting of a single typical V form type accompanied by "imperfect" V forms or W forms have frequently been observed.

On extending the typing procedure to further strains of *B. typhosus,* additional types were encountered. However, as will be seen from table III, the number of typical V form types observed among 625 strains is limited. Table III is designed to show the relative affinity of phage II for various types of *B. typhosus* which have been tentatively designated as types A to J.[4] The various preparations of phage are indicated according to the type of strain on which they were propagated; thus phage A indicates type II phage propagated on a type A strain of *B. typhosus.* The concentrations of the phages are expressed in terms of their titre (T) for their homologous type of *B. typhosus,* this actually ranging from a dilution of 1 in 10^7 to 1 in 2.3×10^8. The activity of the phage for the heterologous types of *B. typhosus* is indicated by the level at which the letter indicating the type is placed relative to the scale of concentrations of the phage. This level indicates the highest dilution of the phage which, applied to plate cultures by the method (standard loop volume) described below, produced either one or more plaques or a demonstrable inhibition of growth. The latter effect, it should be noted, is observed only when very high concentrations of heterologous phage ($T \times 10^6$ or more) are required to produce an effect on the strain. Omission of a type from any of the vertical columns in the table indicates that a 10^6 concentration of the phage was without significant action on the type.

In using type II phage preparations for the typing of *B. typhosus,* a dilution of phage, the "critical test dilution", is selected which under the conditions of the test just produces a sufficient number of plaques to give an area of confluent lysis on the homologous strain of *B. typhosus.* This dilution is indicated by the horizontal broken line in table III, and ranges from a 2×10^2 to a 3×10^3 concentration of the titre of the phage for the homologous strain. The actual dilution employed is determined by two factors: (a) the time and conditions of incubation of the tests and (b) the diameter of plaques produced by the phage on the homologous strain of *B. typhosus.* The latter varies somewhat from type to type. In the case of type D_1, the plaques are definitely smaller than on any of the other strains and thus the concentration of phage D_1 required

[4] *In order to avoid possible confusion, the letter "I" has not been employed in designating the groups.*

to produce confluent lysis is a comparatively high multiple of its titre. Strains B_1, B_2, D_1, and D_2 yield abnormally small plaques when subjected to heterologous phage preparations. For this reason, the relatively high sensitivities of types B_1 and B_2 to heterologous phage preparations do not cause confusion in interpreting the results of typing tests, although such a difficulty might be suggested by the position which the types occupy in table III.

TABLE III

RELATIVE AFFINITIES OF PHAGE II PREPARATIONS FOR TYPES OF *B. typhosus*

Concentration of Phage	A	B_1 A	B_2 A	C A	D_1 A	D_2 A	E A	F A	G A	H A	J A
T	–										
T x 10	–		B_1			D_1		B_1			B_1
T x 10^2	–				B_2			B_2	B_1		
					C		C	C			C
T x 10^3	B_2		C	D_1	D_2		B_1		C		
	B_1			B_1		C			B_2	C	B_2D_1
T x 10^4	C	C		B_2	B_1	B_1	H	H D_1	H	B_1	EGH
							D_1 D_2		D_1		
T x 10^5	GH				E H G	E B_2	G B_2 J	E G D_2	E D_2	E B_2	D_2F
			H	D_2 H	F	F G H	F	J	F	G D_1	
T x 10^6	E J – F D_1	G E F H	E F G D_1 D_2	E F G	J						
	φA	φB_1	φB_2	φC	φD_1	φD_2	φE	φF	φG	φH	φJ

Critical test dilution

T = Lowest concentration of phage which in the standard loop volume will produce an average of one plaque on the homologous type of *B. typhosus*.

As will be seen from table III and fig. I, type A strains are just as sensitive to heterologous phages as they are to their highly specific homologous phage. It will also be noted that two B and two D types are recognized. Phages propagated on types B_2 or D_2 have a high affinity for types B_1 and B_2 or for types D_1 and D_2, respectively but, on the other hand, phage propagated on type B_1 has no significant action on type B_2, while D_1 phage has a relatively low titre for type D_2.

As table III suggests, typical V forms appear to belong to a number of

clear-cut types when examined with the critical test dilution of type II phages. We have not, as yet, observed typical V form strains which might be regarded, according to this method of typing, as intermediate in character between any two main types, and in the succeeding paper will present evidence of type stability of the typical V form. On the other hand, a number of imperfect V form strains have been encountered, and these would seem to represent forms transitional between the typical V and the W form. They exhibit only a transient sensitivity or else a temporary inhibition of growth with strong concentrations of type II phage, and thus cannot be typed. They develop V agglutinogen, are lysed by types I and III phage and the majority are lysed by type IV phage. No clear-cut line of demarcation exists between the forms which we describe as "typical V forms" and "imperfect V forms". The former may be defined as V forms which show a sufficiently sustained sensitivity to type II phage during active growth at 37° C. to permit of their being typed. The term "imperfect V form" is used to denote V form strains which develop sensitivity to phage II only during such a brief and early phase of their growth that they cannot be typed. In this connection the term "imperfect" refers solely to an imperfect development of sensitivity to phage II and to no generally recognized characteristics of the V form.

Before passing to a description of the technical details of typing *B. typhosus*, one further matter deserves mention. This concerns the selection of type strains for the production of typing preparations of phage II. Admittedly, much may remain to be done in the way of identifying more suitable strains as type standards. It has been borne in mind that there is a possibility that one strain may yield a more specific preparation of phage than another of the same type. However, within the limit of our observations, this has not appeared to be the case, provided that fully typical V forms are selected. On the other hand, strains which approximate the imperfect V form and show a relative early development of growth resistant to phage II, have been found to yield weaker phage showing a lower degree of specificity. Such strains have been avoided and long delayed appearance of secondary growth has been a deciding factor in the selection of type strains for preparation of the phages.

THE PRODUCTION AND TITRATION OF TYPE II PHAGE PREPARATIONS

Type II phage may be produced in broth or on agar cultures. For ordinary purposes the former method is simpler and yields preparations of ample activity. The starting point of any preparation should be a single plaque produced on a pure typical V form culture of the type to which the phage is to be conditioned. Where homologous phage is already available, this is obtained by plating high dilutions of phage on the strain but in the case of a new type, a sufficiently strong concentration of a heterologous phage is required. The plaque, with the underlying agar and a little of the surrounding intact culture, is transferred to broth and incubated for 18 to 24 hours at 37° C. The broth culture is next heated for 30 minutes at 58° C., thus killing the bacilli. The temperature does

not affect the specificity of the phage which has a thermal death-point of 69-72° C. Heating is therefore preferable to filtration which entails some loss of phage. Serial ten-fold dilutions of the heated phage from 1 in 10^5 to 1 in 10^{12} are made in 5 or 10 cc. volumes of broth and seeded with similar volumes of actively growing pure V form culture of the required type, diluted so that an estimated 1,000 organisms are added to each tube. The object of this arrangement is to reduce the possibility of secondary growth and to obtain a preparation which originates from a minimum number and which will, at the same time, yield a maximum number of phage particles. The series of tubes is incubated for 20 hours or slightly longer if there are indications that lysis is proceeding. The last clear tube in the series, representing the highest dilution of phage giving complete lysis, is heated at 58° C. When the type of *B. typhosus* on which the phage is being propagated is changed, further propagation of the phage is required. Serial ten-fold dilutions are made from the heated tube of phage, lightly inoculated with the same new type as before and incubated. The highest dilution showing complete lysis is again selected and heated. This procedure is repeated until, from a consideration of the degree of multiplication of phage involved, it is obvious that any phage particles propagated on the previously used type of *B. typhosus* have been effectively eliminated by dilution. In titrating phage prepared in this way, a series of dilutions is tested on the series of V form types (a) in order to determine the critical test dilution to be employed for typing and (b) to confirm that its specificity provides an adequate margin of safety in use. Ten-fold dilutions and then, where necessary, intermediate dilutions are carefully tested by the method described below for the identification of types of *B. typhosus*. With heterologous types of *B. typhosus*, the number of dilutions of phage which must be tested may be restricted if table III is used as a guide in conjunction with a preliminary titration on the homologous type. The conditions of incubation of these tests should be similar to those under which the phage is to be used (*vide infra*). The critical test dilution of the phage is the highest dilution which, under the conditions of the test, yields completely confluent plaques. The appearance obtained with this dilution is illustrated in figs. II, III and IV. Attention is directed to the result shown with phage J on type A which, at the time these tests were carried out, was showing a slight loss in activity and should have been renewed. If kept in the refrigerator when not actually in use the phage, diluted to the critical test dilution, retains its activity for at least several weeks. Typing preparations of phage II should be checked on their homologous type strains once a month or oftener and replaced or corrected if loss in activity is noted. A stock preparation 100 times stronger than the critical test dilution facilitates replacement or adjustment of the phage. It might be noted that theoretically 10 cc. of phage prepared in the way described above will provide sufficient phage for the testing of at least 10,000,000 strains of *B. typhosus*.

In our investigations, we have used neutralization tests with types I, II, III, and IV phage antisera to establish that the phage, when altered in its affinities by alteration of the substrate strain of *B. typhosus*, was actually type II

phage and not a substituted phage arising from a strain of *B. typhosus* of unrecognized lysogenicity or representing an accidental contamination. However, it would seem to be unnecessary to devote space at the present time to the technique of these tests in view of the very large number of tests which can be carried out with a single phage preparation. In any case, contamination of a preparation of phage II with phage of another type should become obvious on titrating the phage on typical V form types of *B. typhosus*.

TECHNIQUE OF TYPING *B. typhosus* WITH PHAGE II

In typing *B. typhosus* with phage II or in subjecting the culture to a preliminary test a plate method is used. While the technique of carrying out these tests is simple, a strict attention to certain details is essential. In brief, the technique is designed to obtain areas of uniform inoculation of the strain on an agar plate on which standard volumes of the phage preparations are superimposed as soon as possible after inoculation and without significantly disturbing the uniformity of bacterial distribution. The nutrient agar plates[5] which are used for the tests must be free from defects which, causing irregularities in the thickness of the medium, will result in uneven growth of different areas of the culture being tested. The plates are dried at 37° C. to an optimum degree on setting and are then stored in the cold room. Insufficient drying causes delay in setting up the tests and excessive drying results in uneven distribution of culture and phage.

Two standard platinum loops, 2.75 mm. in internal diameter, are used alternately to apply the culture and phage to the plate. These are mounted on long handles, the balance of which may be improved with advantage by weighting. While one loop is actually in use, the other is cooling after sterilization. In transferring a loopful of broth culture to the plate, the loop is used merely to direct the natural spreading of the broth and should not be rubbed over the agar. The shank of the loop is angled so that the loop will lie parallel with the agar surface during inoculation, the loopholder being grasped between the thumb and first two fingers like a pen. A full loopful of broth culture is obtained by sharply moving the culture tube so that the loop quickly breaks the surface of the fluid. Then with the holder held in the way described and with the forearm and side of the hand resting on the bench, the loop is lowered until the drop held in it touches the surface of the agar. At this point, the loop is given a slight horizontal circular movement by moving the fingers, guiding the spreading of the drop over an area approximately 15 mm. in diameter. A number of areas, corresponding to the number of phage preparations used in the test, are inoculated with each strain. When the agar has absorbed the fluid which has been applied (optimum 5 to 10 minutes) the phage is applied from the standard loop to the centre of the inoculated area. In this case the loopholder is best held horizontally between the thumb and fingers, these pointing downwards with the side of the arm resting on the edge of the bench. The loopful of phage

[5] *Beef extract-peptone broth in 1 per cent. agar, pH adjusted to 7.8.*

is lowered until it almost touches the surface of the agar when slight rotation of the loopholder will move the loop into a vertical plane, thus allowing its contents to flow onto the centre of the inoculated area. It is to be noted that the drop of phage must be allowed to spread naturally on the plate, and the actual contact of the loop and inoculated area is to be avoided as far as possible.

When the fluid which has been applied has dried sufficiently to permit of the plates being safely moved, they are incubated for two hours at 37° C. and transferred to the cold room overnight. They are returned to the incubator and are ready for reading in 4 to 6 hours. It should be noted that the plates must not be stacked since at temperatures significantly below 37° C. *B. typhosus* will grow without exhibiting lysis with Vi phage. The method of interrupted incubation has two advantages. It permits the phage reactions to be observed at their optimum and before they are obscured by late growth in the case of some strains. Further, the intermediate period in the cold room permits diffusion of the phage into the surrounding normal culture, thus enhancing the clarity of the reactions. The reactions are best observed by oblique artificial illumination and against a dark background.

Preliminary Test

Since the typing of *B. typhosus* with type II phage depends on the production of an area of complete lysis on an agar plate culture, it is obvious that the presence of the W form or imperfect V forms will obscure the reactions obtained. Only a pure typical V form culture can be satisfactorily typed. Unless Vi phage is present in the specimen of origin, the colonies obtained on primary isolation of the organism consist of V forms. Consequently, freshly isolated strains may be typed without preliminary examination. On the other hand, if the strain has been subjected to extensive propagation the probability is that degradation has occurred and re-isolation of the V form becomes desirable. A preliminary test, carried out with phages I and II, serves to indicate (a) the absence of W forms and (b) whether, provided W forms are absent, the culture consists of typical or imperfect V forms.

The strain of *B. typhosus* which is to be tested is inoculated into 2 cc. of nutrient broth and incubated at 37° C. When it has attained a density corresponding approximately to the No. 5 McFarland standard, the culture is plated for test or transferred to the cold room until the following day. In testing, the technical details of applying the culture and phage to the plate are those to be adhered to in the typing test and are described above. It is necessary to use phage I in relatively high concentration because of the minute size of plaques which it produces, particularly on types A and E. This phage should be propagated on the Rawlings strain (type F) and used in a concentration of 10^2 to 10^3 times stronger than its critical dilution for this strain. The preparation of phage II used in the preliminary test is a polyvalent mixture of phages B_2, C, D_2, E, F, G, H, and J, in which each phage is adjusted to a concentration 100 times stronger than its critical test dilution. The broth culture used to set up the preliminary test is thereafter transferred to the cold room until this test is com-

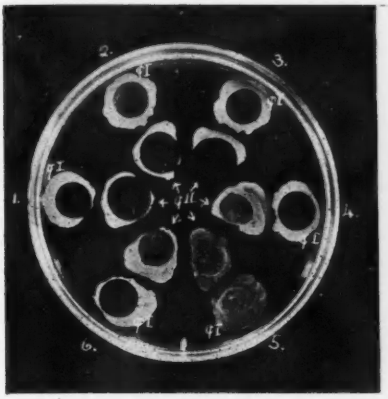

FIGURE I

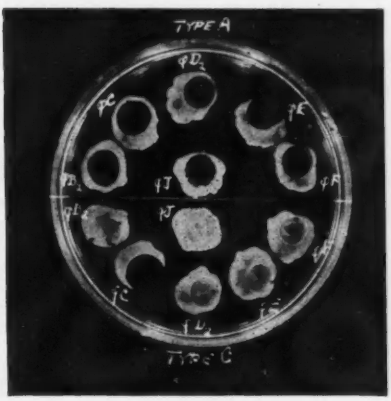

FIGURE II

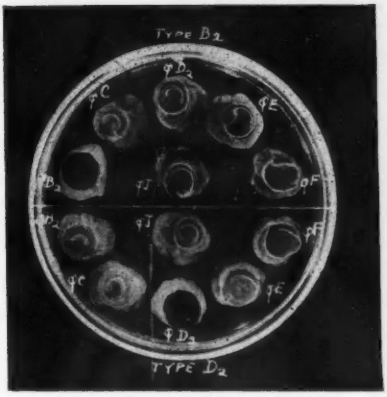

FIGURE III

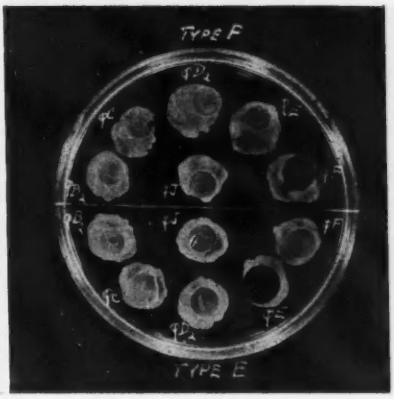

FIGURE IV

FIGURE I

PRELIMINARY TEST WITH PHAGE I AND POLYVALENT PHAGE II; STRAINS OF B. TYPHOSUS ISOLATED 2 TO 4 WEEKS PREVIOUSLY.

1: Typical V form culture (blood specimen). 2: Typical V form culture; this is a type A culture and is figured to show necessity of using phage I in a relatively high concentration if complete lysis is to be obtained with types A and E. 3: Typical V form culture. 4: Imperfect V form; showing retardation of growth but no visible lysis with phage II. 5: W form; resistant to phages I and II. 6: Culture showing imperfect lysis with phage II. From stool specimen from same case as 1. Culture from urine specimen contained only imperfect V forms.

FIGURES II-IV

ROUTINE TYPING OF B. TYPHOSUS WITH CRITICAL TEST DILUTIONS OF PHAGES B_2, C, D_2, E, F, AND J.

Figure II, upper: Type A strain. Phage J preparation shows slight drop in activity (see text).

Figure II, lower: Type C strain. Note the isolated plaques produced by phages B_2, E, and F.

Figure III, upper: Type B_2 strain.

Figure III, lower: Type D_2 strain.

Figure IV, upper: Type F strain.

Figure IV, lower: Type E strain.

pleted. This culture, depending on the result of the test, is used for isolation of the V form or used to determine the type to which the strain belongs.

After being set up, preliminary tests are incubated for two hours at 37° C., transferred to the cold room overnight and then returned to the incubator. The results may be read after 4 to 6 hours of secondary incubation. Complete lysis and absence of resistant colonies with phage I indicate a pure V form culture and continuing peripheral lysis with phage II indicates a typical V form type (fig. I). Complete lysis with phage I accompanied by an absence of any evidence of continued lysis with phage II indicates an imperfect V form (fig. I). Strains apparently intermediate in character between typical and imperfect V forms, may be encountered which show an obvious retardation of growth with polyvalent phage II but show doubtful evidence of lysis at the periphery of the area to which the phage was applied. Decision to test such strains further, with or without colony reisolation, rests on the degree of this atypical reaction and the likelihood of obtaining a sufficiently definite reaction in the typing test.

The appearance of resistant colonies with types I and II phage indicates the presence of W forms and the necessity of resorting to colony isolation. The broth culture of the strain is carefully plated and the colonies inspected with a hand lens after 20 to 24 hours' incubation at 37° C. A colony of the V form of *B. typhosus* is definitely more opaque than a W form colony (*vide* fig. IV, Craigie and Brandon, 1936 a) and this difference in appearance provides a reliable guide to colony selection. One of the most opaque types of colony on the plate is transferred to broth and the culture subjected to a further preliminary test.

Determination of Type

A broth culture (density approximately No. 5 on the McFarland scale) is used as a source of culture for the typing test. This may be (a) an actively growing culture obtained from a single colony picked from the original isolation plate or from a stock culture prepared from such a colony, or (b) a broth culture used 24 to 48 hours previously as a source of culture for the preliminary test. In the latter case, the broth culture must be stored in the refrigerator during the interval between tests. The technique described above is used to set up the tests with the critical test dilutions of phage used in typing.

The nature of the results obtained in this test with several types of *B. typhosus* is illustrated in figs. II to IV, while table IV gives a summary of the reactions of the various types to the critical test dilution of phage II preparations. In the case of types C, E, F, G, H, and J the nature of the type is clear from the production of a confluent area of lysis with the homologous phage. Type C is characterized by a tendency to develop isolated plaques with some heterologous phage preparations (fig. II). Type A, which is equally sensitive to all type II phage preparations,[6] can be identified because of this peculiarity without resorting to the use of phage A (fig. II). Phages B_2 and D_2, having a relatively high titre for types B_1 and D_1 respectively, serve to identify a type as B or D, and a

[6]*Type A phage, it should be noted, has a high specificity (vide table III).*

TABLE IV

THE REACTIONS OF TYPE STRAINS OF *B. typhosus* TO CRITICAL TEST DILUTIONS OF PHAGE II PREPARATIONS

Type of *B. typhosus*	PHAGE II										
	φA	φB₁	φB₂	φC	φD₁	φD₂	φE	φF	φG	φH	φJ
A	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
B₁	−	CL	+++	∓	−	−	∓	+++	+	−	+++
B₂	∓	−	CL	−	+	−	−	+	−	−	−
C	−	−	∓	CL	∓	−	∓	∓	∓	−	∓
D₁	−	−	−	∓	CL	+++	−	−	−	−	−
D₂	−	−	−	−	∓	CL	−	−	−	−	−
E	−	−	−	−	−	−	CL	−	−	−	−
F	−	−	−	−	−	−	−	CL	−	−	−
G	−	−	−	−	−	−	−	−	CL	−	−
H	−	−	−	−	−	−	−	−	−	CL	−
J	−	−	−	−	−	−	−	−	−	−	CL

CL = Confluent lysis with standard loopful of the critical test dilution of phage.
+++ = Numerous discrete plaques, subnormal in size.
∓ = A few plaques, subnormal in size except in the case of type C strains.

further test with phages B_1 and B_2 or D_1 and D_2 is used for complete identification of the type (table IV). Type B_1 shows, to a lower degree and with less regularity than type A, a marked sensitivity to heterologous phages, the plaques produced being too small to produce a confluent reaction. The characteristics of types A, B_1 and D_1 and the infrequency with which types G, H and J have been encountered would seem to justify, in routine typing, a restriction of the number of phages necessary in a first trial. Phages B_2, C, D_2, E and F, supplemented when necessary by phages B_1 and D_1, would have served to identify all but a small percentage of the typical V form strains which we have examined.

DIFFICULTIES IN THE INTERPRETATION OF PHAGE TESTS

Difficulties in the interpretation of the typing test will necessarily arise when a new type or subtype is encountered. In such an event, propagation of phage II on the strain in question and complete examination of the phage by differential titration on known types must be resorted to in order to determine whether the strain actually represents a new type or is in some way atypical. Sometimes strains are encountered the growth of which is not completely inhibited by homologous phage. Instead, the culture shows a marked translucency in the area occupied by the phage, but although this atypical appearance is produced, the type to which the strain belongs can readily be observed. Generally, however, such difficulties as are encountered arise from a different kind of reduction in sensitivity to phage II. It has been mentioned that differences exist in the period of growth during which a strain exhibits sensitivity to the phage. Some strains, on repeated subculture, and without necessarily exhibiting W degradation, have shown a progressive decrease in their period of sensitivity, this being indicated by the time of development of resistant growth. Various degrees of duration of the phage-sensitive portion of the phase of logarithmic growth of a V form strain have been observed, from the extended sensitive period of a fully typical V form to the doubtful or absent sensitivity of the imperfect V forms. These differences might be interpreted as being indicative of a progressive restriction of the period of logarithmic growth during which metabolic processes in the V form provide conditions which enable the phage to propagate. When the period of sensitivity to phage II becomes markedly decreased, it becomes impossible to type the strain which, however, generally retains sensitivity to the other Vi phages and also the ability to develop the serological characteristics of the V form. We have been able to type a few strains, occupying apparently a borderline position between the typical and imperfect V form, by resorting to the use of phages 10 to 100 times stronger than their critical concentration. Although this method has in certain cases yielded results in agreement with observations on related strains or subsequent cultures from the same individual, the reactions obtained cannot always be interpreted with the same certainty as tests carried out with typical V forms.

Indirect Typing of Strains

Further evidence of the identity of strains of *B. typhosus* may be obtained by propagating phage II on the strains in question and comparing the action of the phages thus produced on type strains A to J. With related typical V form strains (e.g., strains from a carrier and cases whom he has infected) the phages produced are not only similar in their relative titres for the type strains but, propagated in the way described above, show a remarkable similarity in actual titre. This method may also be used in special cases where doubt exists regarding the type from which a partially degraded V form was derived. There are two limitations to this course: (a) if the culture approximates the imperfect V form type too closely it will not support the multiplication of phage II; (b) if only slightly less degraded, only feeble propagation of phage is obtained on the strain, necessitating repeated transfers. Further, in the latter case, the phage thus produced tends to show a relatively high titre for some heterologous strains. Careful differential titration of the phage, however, will generally permit of the homologous type being recognized.

SUMMARY

Type II Vi phage exhibits a high selective affinity not only for the particular V form strain of *B. typhosus* on which it is propagated but also for epidemiologically related strains. On this basis a number of distinct types of *B. typhosus* have been recognized. A simplified technique has been developed whereby preparations of phage II can be used to identify these types, and is described in this paper. A further paper will be devoted to the results obtained by means of this method and also to the presentation of epidemiological evidence concerning the question of the significance of the types thus differentiated.

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NEW FINDINGS ON TYPHOID FEVER

In recent years, significant advances have been made in the study of the causal organism of typhoid fever. Although *B. typhosus* was discovered in 1880 by Eberth, it was not until 1933 that the serological and antigenic characteristics of the virulent form of this organism were definitely recognized. This delay was due to the lack of an experimental animal in which enteric fever can be produced and to the antigenic degradation to which strains of *B. typhosus* are subject when propagated on the usual laboratory culture media. Perry, Findlay and Bensted rejuvenated the Rawlings strain, widely employed for the preparation of typhoid vaccine, by mouse passage. Shortly afterwards, Felix and his co-workers discovered that mouse-virulent strains of *B. typhosus* developed a previously unrecognized antigen which they designated Vi antigen. Apart from its property of stimulating the development of a high degree of immunity to the virulent form of *B. typhosus*, this antigen was found by Felix and Pitt to produce an agglutinin distinct from the H and O antigens which are tested for in the sero-diagnosis of typhoid fever. The form of *B. typhosus* which is able to develop Vi antigen is known as the V form and the avirulent form as the W form. There is now extensive evidence that on primary isolation from man, *B. typhosus* exists only as the V form and this form now appears to be generally employed in the preparation of typhoid vaccine. However, the literature of observations which is accumulating concerning the V form and Vi antigen indicates that Felix's observations mark the beginning, not the end, of the chapter on the immunology and metabolism of *B. typhosus*.

The discovery of phages which specifically attack the V form of *B. typhosus* led to a novel but simple method of distinguishing V and W forms, which was described some time ago in this journal. A further report by Craigie and Yen, the first part of which appears in this issue, indicates an interesting advance in the practical application of phage specificity to the recognition of differences in strains of *B. typhosus* which, as far as is yet known, cannot be detected by serological methods. It has, of course, been recognized that strains may differ in respect of certain biochemical reactions and attempts have been made to identify epidemiologically significant differences of this nature. However, the recognition of cultural differences is relatively tedious and their value is apparently limited. Evidence relating to the epidemiological significance of the differences in strains of *B. typhosus* which can be rapidly identified by the phage technique proposed by Craigie and Yen will be published in the October issue.

REPORT OF THE ASSOCIATION'S WORK DURING 1937

Part III

SECOND ANNUAL REPORT OF THE COMMITTEE ON ACCIDENT PREVENTION

THERE has been no halt in the upward trend of the traffic accident rate in Canada during the past year. The Committee has been interested to learn, however, that the Province of British Columbia has added courses in driving instruction to its high school curricula; has placed upon the provincial statute books a new Motor Vehicle Act embodying some of the most advanced legislation on this continent; and the Provincial Health Department has assumed the duty of keeping highway accident statistics. In Toronto, the establishment of Canada's first school of instruction for traffic offenders is a step which holds much promise for the future.

The Committee is fortunate to be able to report that Doctor J. S. Cull, Assistant Provincial Health Officer for British Columbia, has kindly consented to act on this Committee. Professor Chant, a member of this Committee, is continuing his investigations into certain problems in connection with vision and their relation to driving habits.

The Committee learned with interest the experience of one large organization which gave a refresher course to all its nurses who operated cars. Following the course, the accident rate among the nurses was reduced fifty per cent. Perhaps of even greater interest to this Association is the fact that examination disclosed a rate of over seven per cent. of medical disabilities liable to affect driving.

Your Committee re-affirms its belief that accidents in general, and traffic accidents in particular, constitute matters of grave concern to workers in the public health field. Furthermore, the definite need for a scientific approach to the accident problem makes it clear that the active interest of health departments would immeasurably strengthen present efforts in the safety field and that if there were created an intelligent public opinion, it would help bring about the desired co-operation between public health and official and non-official safety agencies.

Consideration has been given by the Committee to defining its objectives for future work. These are presented for approval as follows:

1. *Statistical*—Investigation into the nature and scope of accident statistics now kept throughout Canada, to the end that consideraion might be given at a later date to suggested standard procedures and practices in this field.

2. *Educational*—Exploration of the possibilities of bringing to the attention of the general public as well as those in the public health field, available knowledge

of medical disabilities, psycho-physical, and other factors liable to affect driving.

3. *Research*—Reviewing available material in the field of accident research and stimulation of further investigation into the causes of accidents where possible and practicable.

DR. N. L. BURNETTE, *Chairman*; DR. J. T. PHAIR, DR. A. HARDISTY SELLERS, PROFESSOR S. N. F. CHANT, DR. A. GRANT FLEMING, DR. J. G. CUNNINGHAM, DR. J. M. LIVINGSTON, and DR. J. S. CULL.

REPORT OF THE STUDY COMMITTEE OF THE PUBLIC HEALTH NURSING SECTION

THE Committee was appointed by the Public Health Nursing Section in 1935 to study such problems as might be referred to it by the Section.

The decision was made to study first the requirements for the employment of public health nurses throughout Canada. A questionnaire was sent to the official provincial and municipal departments of health, non-official health agencies, and industrial companies employing public health nurses. From the many replies received, the Committee believed that the preparation of minimum standards was highly desirable. Before, however, such minimum standards could be presented, further enquiry was found necessary.

To this end the Study Committee presented certain resolutions to the Section, including a recommendation that a separate committee be appointed to study personnel practices. Miss Elsie Hickey, Director of Public Health Nursing, Department of Public Health, Toronto, was appointed convenor of this committee. Owing, however, to the greatly increased work occasioned by the outbreak of poliomyelitis in Toronto, Miss Hickey was unable to appoint the members of the committee and to carry forward the study. Plans have been made for this work to be undertaken and it is anticipated that recommendations regarding minimum requirements will be made at the next annual meeting.

The Study Committee has before it other subjects for immediate consideration. It is evident that there is a wide field for the work of the Section of Public Health Nursing in investigation and study of public health nursing practice.

LAURA A. GAMBLE, *Convenor, Study Committee.*

FIFTH ANNUAL REPORT OF THE COMMITTEE ON THE ANNUAL REPORT OF THE MEDICAL OFFICER OF HEALTH

THE Committee are pleased to report that with the amendment to the Public Health Act in Ontario, passed at the last session of the Legislature, all annual reports of municipal departments of health now relate to the calendar year. The Committee have continued to draw attention to this need in

previous reports, since comparability of statistical data would be made possible by the adoption of the calendar year for health reports. It is also gratifying to the Committee that the purposes of the annual report of the medical officer of health are being increasingly recognized. In the place of the former attitude that the annual report was a matter of record, possessing little or no interest for the public, many medical officers of health have accepted the suggestions of the Committee, preparing their reports along new lines with the definite objective of fostering an intelligent and active public interest.

As space does not permit the reviewing individually of the excellent reports received, only a general reference is possible. Although only one city that formerly had a mimeographed report has been able to issue a printed report this year, the typewritten or mimeographed reports of a number of cities have been greatly improved in their attractiveness. Printed covers have been used in some instances, with the body of the report in mimeographed form. The reports of the larger cities which have been issued in printed form have been improved; tables of contents have been included, and the statement made by the health officer has been more extended, reviewing the progress made during the year and in some instances drawing attention to problems needing consideration. Almost all the cities have adopted the standard statistical tables which were prepared by the Section of Vital Statistics and Epidemiology and made available by the Committee. The tables have been found to be practical work-sheets by health officers. With space provided in many of the tables for the data of the preceding five years, the health officer is able to compare the results and to see the problems as they exist.

The Committee will issue this year tables in abridged form for rural and smaller municipalities. To this end the Department of Health of Ontario has signified its willingness to incorporate such tables in the report form required for health officers of such municipalities.

The Committee regret that no meetings were held during the year to deal with the question of health budgets. The subject has been discussed informally and considerable thought has been given by a number of members to the problem of defining those activities which may properly be considered the responsibilities of the health department. There is general agreement as to the exclusion from health budgets of such expenditures as relate to street cleaning, garbage collection, and other activities usually associated with the department of works. It is hoped that if the Committee is continued, recommendations will be possible of presentation at the next annual meeting.

The Committee have continued to supply statistical forms for the use of medical officers of health of cities of more than 10,000 population.

MARY POWER, *Secretary.* D. V. CURREY, *Chairman.*

SECOND ANNUAL REPORT OF THE COMMITTEE ON THE REMUNERATION AND DUTIES OF THE MEDICAL OFFICER OF HEALTH

YOUR Committee, reporting last year, stated that after careful review of the governing legislation, both statutory and regulatory, it found that any arbitrary division of the duties of the Medical Officer of Health into those fixed and those implied, led to difficulty in a further effort to define what might rightly be considered to be the obligations of this office. While in some provinces this comment is less applicable than in others, it is in the main more or less true of all. It is suggested that the guiding legislation be interpreted to imply that the health officer has an official concern with all matters that affect either favourably or otherwise the public health; and that he can with safety presume that he will receive both public and official support if he interprets his duties broadly.

Further effort has been made to establish a satisfactory basis upon which the remuneration of the health officer might be computed. Difficulty presents not only in the urban municipality too small to justify the appointment of a full-time health officer, but in the rural and suburban community as well. Such factors as size, density of population, extent of industrialization, social and economic status of residents, present in the town or city; while size, population, how distributed, facilities for transportation, main source of population's income, etc., affect the amount of salary to be paid the Medical Officer of Health in the rural municipality.

In view of the difficulty of evolving any generally acceptable solution of the many difficulties presenting, your Committee in submitting this report, ask that it be discharged.

J. E. DAVEY, *Chairman;* WARD WOOLNER, J. W. FRASER, J. T. PHAIR, and A. L. MCKAY, *Secretary.*

FOURTH ANNUAL REPORT OF THE COMMITTEE ON MILK CONTROL

AS presented in last year's report, the Committee is conducting its work through the several sections of the Association that are concerned with the production and distribution of safe milk. In the laboratory field Dr. M. Doreen Smith published detailed studies on the phosphatase test as applied to Ontario milk. Another contribution was made by Dr. E. J. Reedman, presenting data relating to the ascorbic-acid (vitamin C) content of milk. The Committee on Standard Methods of the Laboratory Section as relating to the examination of milk has conducted a series of studies. The chairman of the committee, Dr. Ambrose Moffat, presented the findings relating to the presence of coliform organisms in pasteurized milk. These findings are highly significant

and indicate that the estimation of coliform organisms may be helpful in checking the efficiency of the pasteurization process. Valuable contributions have been made by Dr. A. J. Slack, Director of the Institute of Public Health, London, Ontario, and Mr. M. H. McCrady, Chief of Laboratories, Ministry of Health of Quebec, Montreal, as representatives on the Committee on Standard Methods of the American Public Health Association. Professor H. R. Thornton of the University of Alberta has made substantial contributions in his extensive study of the methylene-blue reduction test, and as a member of the Standard Methods Committee of the American Public Health Association has taken an active part in evaluating the laboratory procedures in milk control.

Consideration has been given by the Department of Pensions and National Health, through the Laboratory of Hygiene, to establishing standards for ice cream, both as to quality and bacterial content. This aspect of the milk problem has not received the attention that it merits, and the action of the Laboratory of Hygiene in the investigations that they have made is greatly appreciated.

Dr. A. E. Berry and other members of the Public Health Engineering Section have been concerned with new types of dairy equipment and investigations have been made to determine the efficiency of certain pieces of new equipment. In the course of inspections conducted in the various Provinces by provincial and municipal departments of health valuable information is being obtained concerning defects that may be found in pasteurization plants either through faulty design or improper operation. The Committee hopes to present a detailed statement of these composite findings so that as inspection is more widely conducted throughout Canada, such defects may be more readily recognized.

In the Section of Vital Statistics and Epidemiology information has been obtained, through the kind co-operation of the various provincial departments of health, as to the occurrence of milk-borne infections, either in single cases or in outbreaks. Information has been sought concerning the occurrence of typhoid fever, paratyphoid fever, septic sore throat and undulant fever. The Committee recognize that to this list must be added staphylococcic food poisoning. In several laboratories, studies have been conducted corroborating the findings of Dr. C. E. Dolman that definite poisoning may follow the consumption of milk or cream products infected with staphylococci. The Committee have received data concerning such outbreaks in Vancouver, Hamilton, and Toronto, and detailed reports will be published in the *Journal*. The Committee believe that such poisonings are much more frequent than has been thought.

The Committee have assembled data concerning the extent of pasteurization in Canada through enquiry to three hundred municipalities, and, through the co-operation of the Department of Health of Ontario, of all municipalities with dairies in that Province. The report of this survey has been published in the June issue of the *Journal*.

To permit of disseminating the information obtained during the year and

of reviewing the present status of milk control in Canada, the Committee arranged with the Editorial Board for the publication of a special milk number. The success of the two previous milk numbers warranted the Editorial Board in acceding to the request and in arranging for a series of papers covering the whole field of the production and distribution of safe milk. It is purposed that this special number will be available in reprint form so that it may be of wide service.

The interrelationship of the various activities of the Association as they relate to safe milk is well illustrated by reference to the work of the Committee on the Certification of Sanitary Inspectors. That committee has established standards, conducts examinations, and issues certificates to qualified inspectors. An essential requirement is an adequate knowledge of dairy farm inspection and the inspection of dairy plants. The Committee were fortunate in having the section of the Manual of Instruction dealing with milk prepared by Dr. A. R. B. Richmond, Director of the Division of Food Control, Department of Public Health, Toronto. As a result of the attention given to the subject of milk, sanitary inspectors holding the certificate of the Association will be able to conduct more effectively their duties and contribute definitely to the general educational effort which is so essential in municipalities if adequate milk control is to be attained.

The increasing recognition of the importance of pasteurization in safeguarding milk is evidenced in a striking manner by the legislation enacted at the recent session of the Ontario Legislature which requires the compulsory pasteurization of all public milk supplies. Ontario has the honour of being the first Province or State on this continent to require compulsory pasteurization. The Government, however, does not purpose to proclaim the Act in all municipalities immediately, but to introduce the measure gradually, commencing with the larger municipalities. The Act in Ontario, together with the progress in other Provinces, has been reviewed and presented in the milk number.

In presenting this report the Committee believe that the work is of such a character that the services of a part-time salaried secretary would facilitate greatly its undertakings. This would make possible the publication each year of the essential advances in the field of milk control, with the compilation of data of essential value to all public health administrators.

A. E. BERRY, *Secretary.*

REPORT OF THE COMMITTEE ON ARCHIVES
1937-38

IT is with deep regret that the Committee on Archives reports the loss by death of the following members during the past year:

Dr. W. E. Anderson, Medical Officer of Health, Lake Alma, Saskatchewan.
Dr. H. L. Barber, Medical Officer of Health, Noelville, Ontario.

Dr. F. H. Bethune, Medical Officer of Health, Emo, Ontario.
Miss Elizabeth Breeze, Reg.N., Head Nurse of the Metropolitan Health Committee, British Columbia.
Dr. E. D. Carder, Epidemiologist, Metropolitan Health Committee, Vancouver, B.C.
Dr. J. L. Easton, Medical Officer of Health, Ayton, Ontario.
Dr. H. A. Elliott, Medical Officer of Health, Leaside, Ontario.
Dr. J. S. Freeborn, Medical Officer of Health, Magnetawan, Ontario.
Dr. B. J. Funk, Medical Officer of Health, Herbert, Saskatchewan.
Dr. H. H. Galloway, Medical Officer of Health, Alameda, Saskatchewan.
Dr. Duncan Gow, Medical Officer of Health, Calgary, Alberta, and Medical Superintendent of the Calgary General Hospital.
Dr. C. J. Hamilton, Medical Officer of Health, Cornwall, Ontario.
Dr. J. H. Hamilton, Medical Officer of Health, Revelstoke, British Columbia.
Dr. R. T. Kidd, Medical Officer of Health, Atwood, Ontario.
Dr. A. J. Leach, Medical Officer of Health, Kenaston, Saskatchewan.
Dr. G. Longault, Medical Officer of Health, Bruno, Saskatchewan.
Dr. J. F. McKee, Medical Officer of Health, Thornbury, Ontario.
Dr. A. J. McKinnon, Medical Officer of Health, Zurich, Ontario.
Dr. M. A. MacKinnon, Medical Officer of Health, Punnichy, Saskatchewan.
Dr. A. E. McRitchie, Medical Officer of Health, Qu'Appelle, Saskatchewan.
Dr. H. G. Murray, Medical Officer of Health, Owen Sound, Ontario.
Hon. W. F. Roberts, M.D., LL.D., Minister of Health and Labour for New Brunswick.
Dr. J. F. Scribner, Medical Officer of Health, Sceptre, Saskatchewan.
Dr. C. L. B. Stammers, Medical Officer of Health, Smith's Falls, Ontario.
Dr. M. Stinson, Medical Officer of Health, Fairy Glen, Saskatchewan.
Dr. L. P. Thiboutot, Medical Officer of Health, County Health Unit of Labelle, P.Q.

The passing of these members constitutes a serious loss to the Association and to the communities in which they served.

G. D. PORTER, *Chairman*; J. D. PAGE, and J. W. S. MCCULLOUGH.

PLANS, PROGRAMS, AND PROGRESS

New Government Program for Sanatorium Care of Tuberculous Patients in Ontario

IN a recent communication the Honourable Mr. Harold J. Kirby, Minister of Health, outlined the provision that has been made by the Government of Ontario to relieve the municipalities of the cost of maintenance of indigent patients in sanatoria pursuant to the legislation passed at the last session. The program became effective on July 1st.

This legislation was introduced as a result of an extensive study of the program of tuberculosis control which revealed that in many instances suitable and necessary care for those suffering from this disease had frequently not been provided because of the cost to the municipalities. Heretofore approximately half of the patients dying from tuberculosis have not received the benefit of sanatorium treatment. Furthermore, the burden of the costs of sanatorium care has been strikingly unequal from municipality to municipality throughout the Province.

Previously, all cities, separated towns and counties were required by statute to pay $1.50 per day for the treatment in sanatorium of each indigent person suffering from tuberculosis. In the case of counties, one-half of this amount was charged back to the township, town or village, as the case might be. The amount of money raised by the municipalities through taxation for this purpose amounted to $1,350,000.00 last year.

While the bulk of the financial burden, formerly borne by the municipalities, has been assumed by the Government, the responsibility for the after-care of certain patients is still left with the municipalities.

Failure on the part of the municipality to supply such after-care will result in the retention of these patients in sanatorium at the expense of the municipality. Such cost would be greatly in excess of that entailed in providing proper living accommodation and treatment outside the sanatorium.

When pneumothorax treatments are necessary following the discharge of indigent patients from sanatoria, the municipalities are required to provide transportation from the place of residence to and from the nearest centre in which such treatment facilities are available, and to pay physicians approved by the Department for giving these treatments. The Government, however, will reimburse the municipality for the amount paid to these physicians up to $3.00 per refill treatment. Patients who are able to pay all or part of their maintenance in sanatorium will be expected to do so as heretofore.

The Minister stressed the fact that the Government is taking no additional responsibility whatever with respect to public general hospitals and the care of indigent patients therein. Such institutions will continue to receive Government support in the way of statutory per diem grants but the main responsibility for their operation will, as in the past, remain with the communities which they serve.

Compulsory Pasteurization of Milk in Ontario

THE Milk Pasteurization Act passed at the last session of the Legislature of the Province of Ontario becomes effective on October 1st. For the present the law will be effective for all towns and cities and certain other areas declared by Order in Council. These other areas are for the most part municipalities adjoining larger cities and towns.

Poliomyelitis in Canada

THE reported cases of poliomyelitis in Canada from January 1st to August

27th in the various Provinces are as follows: British Columbia, 34; Alberta, 68; Saskatchewan, 15; Manitoba, 47; Ontario, 94; Quebec, 34; New Brunswick, 6; Nova Scotia, 5; and Prince Edward Island, none.

IMMUNIZATION IN UNORGANIZED DISTRICTS IN ONTARIO

IN the fall of 1937 it was possible for the Department of Health of Ontario, with the co-operation of the Ontario Division of the Canadian Red Cross Society, to offer immunization to those school sections which were conveniently located in relation to the Red Cross Outpost hospitals. This work was carried out by physicians in the area and with the assistance of the Red Cross Outpost nurses. The fee paid to the physicians by the Department was $2.50 per school or preschool child when the three inoculations of diphtheria toxoid were given and successful vaccination carried out. Certificates were issued to the children indicating that such work had been completed.

The favorable response to this offer prompted the Department early in April 1938 to institute a similar procedure for all of the schools situated in the unorganized municipalities of the Districts of Kenora, Rainy River, Thunder Bay, Sudbury, Algoma, Temiskaming, Cochrane, and part of Nipissing.

After consultation with the executive officers of the Ontario Medical Association it was decided that the fee which had been paid in the campaign of 1937 ($2.50 per child) should be applicable also in this campaign.

The approval and co-operation of the Department of Education of Ontario was received and letters were forwarded from the office of the District Inspectors to each teacher of the schools situated as outlined above, urging their co-operation in making the campaign a success. A letter from the Chief Inspector of the province was forwarded to each Inspector outlining his responsibility in this regard. Following this, a letter went forward from the Department of Health to each teacher, giving instructions as to how they should co-operate, and enclosing consent forms both for diphtheria toxoid and smallpox vaccination, which were to be signed by the parent or guardian and returned to the teacher; literature was also supplied on the use of diphtheria toxoid and smallpox vaccine, to be sent home with the consent cards by the teacher.

The arrangements for the physicians to undertake this work were made by letter. The schools were allocated by the central office. Each physician was requested to do this work in the schools in his immediate vicinity in order to minimize mileage. Two officers from the Department proceeded to Northern Ontario and facilitated in every way possible the arrangements for the physicians to visit the schools and to undertake the work.

In the case of physicians in the larger centres who were to give the treatments in the unorganized surrounding municipalities, the secretaries of the medical societies in Kirkland Lake, Timmins, Sudbury, Sault Ste. Marie, Fort William, and Port Arthur, were asked to name physicians who would be willing to undertake this work and who would be acceptable to their local society.

Work Completed

The estimated population under 15 years of age in these districts is 25,000. By July 26, 1938, 13,530 children received either diphtheria toxoid or smallpox vaccination or both. Of this number, 12,195 were successfully vaccinated against smallpox; 10,675 children received 3 doses of diphtheria toxoid; 514 children received 2 doses of diphtheria toxoid; and 361 children received 1 dose of diphtheria toxoid. Nineteen hundred and eighty received smallpox vaccination only.

As all accounts have not been received, it is estimated that the cost will

be $30,000, including payments to physicians $27,527, diphtheria toxoid $900, and vaccine virus $600.

ANNUAL MEETING, CANADIAN INSTITUTE ON SEWAGE AND SANITATION

THE annual meeting of the Canadian Institute on Sewage and Sanitation will be held in the Royal York Hotel, Toronto, on October 20th and 21st. The President of the Institute is Mr. Norman J. Howard, Director of Water Purification, Toronto, and the Secretary-Treasurer is Dr. A. E. Berry. Copies of the program may be obtained by addressing the Secretary-Treasurer, Department of Health, Parliament Buildings, Toronto.

PERSONALS

DR. Eugene Gagnon and Dr. Adrien Plouffe have been appointed Assistant Directors of the Department of Health, City of Montreal. Dr. Gagnon will continue to direct the Division of Demography.

DR. R. S. Peat, D.P.H., has been appointed Medical Officer of Health of Kingston, Ontario, succeeding Dr. C. F. Blackler, who recently resigned.

DR. J. A. Taylor, D.P.H., has been appointed Director of the newly-organized Fraser Valley Health Unit in British Columbia.

BOOKS AND REPORTS

Child Care and Training. *Marion L. Faegre and John E. Anderson, Institute of Child Welfare, University of Minnesota. University of Minnesota Press, Minneapolis, 1937. 327 pages. $2.50.*

THIS book has become well known since it was first published in 1928 and this, the fourth edition, is expanded and brought up to date. Many new photographs and a new chapter on social development have been added.

"Child Care and Training" is a very practical book based upon years of research at the Institute of Child Welfare in the University of Minnesota. To parents it offers sound guidance in measures for the health and happiness of children. Answers to the many questions which present themselves to every parent are clearly presented. More than that, this book contains a clear statement of the essential facts about growth in all its phases which is especially valuable to anyone responsible for the care and training of a child.

The inclusion at the end of each chapter of a list of questions for discussion and supplementary reading makes the book even more valuable.

A. Hardisty Sellers

The 1937 Year Book of General Medicine. *Edited by George F. Dick, M.D., Lawrason Brown, M.D., George R. Minot, M.D., S.D., F.R.C.P., William B. Castle, M.D., A.M., William D. Stroud, M.D., and George B. Eusterman, M.D. The Year Book Publishers, Inc., Chicago. 832 pages. $3.00.*

THE handicap under which the average medical practitioner labors both in time and opportunity in attempting to keep abreast of medical literature is well recognized. The Year Book of General Medicine provides an answer to this problem. The contents are divided into five parts: infectious diseases, diseases of the chest, diseases of the blood and blood-forming organs, diseases of the heart and blood vessels, and diseases of the digestive system. The important contributions for the year in each of these fields are carefully selected and edited by well-known authorities.

Accumulation of this Year Book series will in time provide a most interesting commentary on the advances in medical science.

F. O. Wishart

Principles and Foibles of Cancer Research in regard to Etiology and Nature. *William Rienhoff, Sr., M.D., F.A.C.S. Published by the author, Baltimore, Md., 1936. 200 pages.*

STUDENTS of cancer, particularly those whose principal interest is directed towards etiology and nature, will appreciate Dr. Rienhoff's semi-critical, logical presentation of the essential points, and especially his vigorous preamble. Though few readers will agree with all of the author's views, the monograph must be regarded as a helpful contribution. Over 600 references are included in the text, one of the objectives of which is to attempt to "deflect the present-day cancer research from its intricate and most speculative tendencies, and induce it to become conscious again of simplified and strictly natural scientific efforts."

A. Hardisty Sellers

Research Memorandum on Crime in the Depression. *Thorsten Sellin, Professor of Sociology, University of Pennsylvania. Bulletin 27 of the Social Science Research Council, 230 Park Avenue, New York City, 1937. 133 pages. $1.00.*

THE Social Science Research Council has prepared a series of thirteen monographs upon social aspects of the depression. The purpose of these volumes is to aid and stimulate research. The author or authors of each monograph present critical examinations of the literature on the influence of the depression upon the field under consideration. The objectives are firstly, to set forth existing information and opinion already established; secondly, to determine the nature of important defects in our knowledge in each field, and thirdly, to set out specific problems in need of study and research. These monographs will without doubt serve to stimulate interest in and study of the influence of depression upon various aspects of society.

The Research Memorandum on Crime in the Depression is full of general interest. Throughout the discussion of various aspects of this subject, many practical questions are raised. It is frequently assumed that criminality is to some degree influenced by economic conditions. Many writings the world over have dealt with property as a cause of illegal conduct. The relation of depressions to crime has not, however, been adequately explored though many opinions have been expressed. In many instances the inadequacies of available data have been a material limitation to conclusive examination of the various aspects of the problem.

A. Hardisty Sellers

Research Memorandum on Social Aspects of Health in the Depression. *Selwyn D. Collins and Clark Tibbitts. Bulletin 36 of the Social Science Research Council, 230 Park Avenue, New York City, 1937. 192 pages. $1.00.*

THE *Research Memorandum on Social Aspects of Health in the Depression* is a most comprehensive document and is of great interest to research workers in the public health field. The relation of health to environment and economic status is discussed under several heads and at the end of each section an outline of suggested studies is given.

"Many presumed consequences of the depression are cited as possibilities rather than facts." This indicates the scanty nature of any knowledge available. Continued research is urged. At present many hypotheses may be suggested as representing the influence of the depression on health. Conservation of health is an important public concern, both in times of depression and in prosperity, and many gaps in our knowledge need to be filled. Extensive references are given to assist the student interested in any specific study.

A. Hardisty Sellers

CURRENT HEALTH LITERATURE

Immunity to Smallpox

THIS paper deals with the results of vaccination against smallpox in 1,053 students who were matriculating at Kansas State College. Of this group, 18.4 per cent. had neither been vaccinated nor had smallpox, 3.5 per cent. had not been vaccinated but claimed to have had smallpox, and 78.1 per cent. had been previously vaccinated and had a scar.

Vaccination was carried out by the multiple puncture method and the results were classified as follows: (a) immune or immediate reaction, height of the reaction being reached within 24 to 48 hours; (b) primary take; (c) secondary take, same as (b) except for its occurrence in an individual with a visible vaccination scar or with pock marks; (d) accelerated reaction, same as primary take except that reaction was less pronounced, developed more rapidly and disappeared earlier. The percentage distribution by groups was as follows: (a) 38.5, (b) 19.6, (c) 7.0, (d) 34.9. Accordingly 26.6 per cent. had no protection against smallpox and 34.9 per cent. only a partial immunity, making a total of 61.5 per cent. who were in some degree susceptible to smallpox and who therefore represented a definite public health problem.

M. W. Husband and David T. Loy, J.A.M.A., 1937, *109*: 1797.

Microbial Flora of Paper Containers

THIS investigation was prompted by the present trend to use paper bottles in the fluid-milk trade. The advantages and disadvantages of paper and glass bottles are fully reviewed. In the manufacture of the former, it was found essential that pure virgin pulp be used in order to obtain paper of satisfactory sanitary quality. Hot paraffin (82.2°C.) applied to the paper board does not give a sterile surface but causes a marked reduction in numbers of viable micro-organisms. Examination of paper bottles showed the average bacterial count to be much lower than for glass bottles and always well within any standards proposed for the latter. Types of organisms found were of no sanitary significance. In view of these findings and the obvious advantage of a one-service container, paper bottles are recommended provided that they are of high quality.

Fred W. Tanner, Am. J. Pub. Health, 1938, *28*: 587.

The Survival of Typhoid in Nature

THE article deals with experimental work on the survival of *S. typhi* under as nearly natural conditions as possible, in filtered and polluted sea water, in fresh water, in various types of soil, in treated sewage, and in ice.

In fresh and both filtered and polluted sea water, 85 to 97 per cent. of the organisms usually died in the first two days, but survivors were at times demonstrated after 32 days. Longer survival in clean water was the rule. *E. coli* was found to outlive *S. typhi*, thus confirming the value of the former as an index of pollution.

Determining factors in the survival of *S. typhi* in soil were found to be the moisture-retaining power of a soil, temperature, humidity, rainfall and pH.

Under septic tank conditions, 98 per cent. of typhoid organisms died in 4 days but a few organisms were viable after as long as 27 days. Activated sludge aeration for 8 hours killed 99 per cent. of the typhoid organisms while aeration alone seemed to have no killing effect. Trickling filters gave a 95 to 99 per cent. reduction of *S. typhi* according to the method and dosage used.

Infectivity of ice was found to be related to the rapidity of freezing and the amount of débris entrapped in the process.

Paul J. Beard, J. Am. Water Works A., 1938, *30*: 124.